THE TELEGRAPHIC JOURNAL AND

Electrical Review.

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THE INSTITUTION OF CIVIL ENGINEERS.

THE Council of the Institution of Civil Engineers has issued a list of subjects upon which it invites papers during the session 1888–89. The list is of the usual comprehensive character; indeed, it may almost be said to be in advance in suggestiveness of former emanations from the same source with the like purpose. If it has not in some instances quite outstripped achievement, it certainly points the way to investigations in little-known fields, research in which must tend to increase our knowledge in most important directions. For instance, the first subject set down is "The Utilisation of Unused Sources of Power in Nature—such as the Tides, the Radiant Heat of the Sun, &c." Here is a wide scope for enquiry! It is the dream of many an engineer to procure the full utilisation of the forces of Nature—forces of enormous power now literally running to waste. Who knows but that the incentive offered by the Institution of Civil Engineers may induce some ambitious young engineer, seeking for a sufficiently promising direction in which to apply his genius, to turn his thoughts towards the elucidation of this subject, with a result perhaps that may not at once, or soon, become apparent, but which in the course of a few decades may come upon the world as a revelation of engineering skill and of the economic powers of Nature. Great advances in knowledge, in engineering science no more than in any other, rarely come suddenly. There is usually a process of evolution—first, the germ, an idea, a scarcely conscious swift-passing thought of a possibility; then the laborious pursuit of this vague idea; presently a crude device based upon a cruder theory; gradual enlightenment and improvement following upon persistent experiment; and eventually the completed, the perfect, or nearly perfect, engine, machine, instrument, or what not. It is scarcely to be expected, therefore, that the invitation of the Institution of Civil Engineers will result in the immediate production of some valuable means of employing waste forces; it may, however, and we hope it will, give the requisite tendency to some fresh young mind, supply the germ which, developed hereafter, will place in men's hands a new power.

What we have said of this one cited subject applies to others in the list: but most are of a more immediately practical character. We extract a few at random to indicate the usefulness of the course pursued by the Institution: Construction, ventilation, and working of railway tunnels of great length; Value of metallic bridges; Sale of water by measure; Effect of wind upon structures; Forging and casting by hydraulic pressure; High speeds on railways; Mechanical traction on common roads; Petroleum engines; Construction and working of windmills suitable for raising water for the supply of villages and isolated houses; Steam cultivation by digging and by ploughing. These, it will be admitted, are full of suggestion to the practical engineer, and we trust the outcome of the Institution's spirit of enterprise may prove sufficiently encouraging to ensure the continuance of so sensible a system. Notwithstanding recent improvements and developments, we fancy it is still open to us to urge our own Society of Telegraph Engineers and Electricians, shortly to become the Institution of Electrical Engineers, to emulation of the more thorough and business-like methods of the Civil Engineers. As has been said before, there is need for the younger and more special society to bestir itself if it is not to have the ground cut from under its feet by its friendly elder. We have given a few specimens of the subjects in general engineering upon which the Institution of Civil Engineers invite communications. Here we will set out in full that part of the list which deals exclusively with electrical subjects, and it will at once be seen how energetically and comprehensively the Institution caters for the electrical engineer, and endeavours to secure his adhesion to itself :—

43. The Generation of Alternating Currents in Dynamo-Electric Machines, and their utilisation for Lighting and Power purposes.
44. Electric Meters for recording the Consumption of Electrical Energy.
45. The Construction and Maintenance of Secondary Batteries.
46. Central Station Electric Lighting.
47. The application of Electricity to the Working of Street Tramways and of Railways.
48. The application of Electricity to the Working of Cranes, Pumps, Tools, &c.
49. The application of Electricity to Smelting and Metallurgical Operations.
50. The application of Electricity to the Purification of Water and of Sewage.
51. The Purification of Copper, and the Reduction of Copper Ores by Electrolytic processes.

THE paper written by Mr. Gray will be acceptable to the readers of the ELECTRICAL REVIEW. In these days, when discussions concerning the nature of electricity are rife, and each seeks some new analogy by which it can be understood, the matter will doubtless prove of interest. We have not carefully examined the conception, but think it is a further development of Prof. Lodge's ideas, with rather ambitious attempts to describe, in accordance with them, all electrical phenomena.

IS it possible that the servitude of the *employés* of some telephone companies is made to approach as closely as possible to slavery? A month or so ago a correspondence took place in the columns of a Scotch paper upon the subject of telephone linesmen's grievances, and some very bitter things were then said. We have now before us a letter from the *Glasgow Mail*, which is headed "Telephone Company's Slavery," in which complaints are made that the staff (of the Glasgow exchange, presumably), is quite inadequate for the work requiring to be done. The operators, it is said, through overwork become ill at their posts, and are laid up in consequence. The princely remuneration of 6s. per week is paid, according to "One of Them," the writer of the letter, to the switch-room girls, who are on their feet, "as busy as can be," from 9 a.m. to 6 p.m., with scarcely time enough to take dinner. In addition to their legitimate work, these operators, who are mostly from the middle class, intelligent and respectable, have in succession to be at the exchange at 7 in the morning to do the work of a charwoman. Out of their 6s. a week they are expected to contribute to every present made by the *employés* to officials, many of whom are entirely unknown to them. If these statements are true, we can only think that the internal administration of the telephone company in Scotland is conducted in a singularly illiberal manner. It would be nothing short of astonishing to find a good service where the remuneration of those upon whom good service depends is so miserably small as that stated to be given at Glasgow. We have always thought that the National Telephone Company was amongst the best conducted of similar enterprises, and we shall still hope that some adequate explanation of the complaints of its operators may be forthcoming. Later correspondence in the same paper seems only to corroborate the statements of the first writer; the company itself has not yet broken silence.

A CURIOUS illustration of the proneness of the lay Press to commit laughable blunders when dealing with technical matters is afforded by the *Fife Herald* of October 10th, which, describing the new electric launch on the Thames, the *Viscountess Bury*, speaks of it as an electric *steamer!*

WHEN the British Association for the Advancement of Science was formed in 1831 few of its members would have deemed it probable that in little more than half a century a similar organisation would be established in the vicinity of Botany Bay. At the first meeting of the British Association, which was held at York, 353 persons attended. At the gathering which recently took place in Sydney 750 have enrolled themselves as members. Thirty-nine scientific societies existed in the United Kingdom in 1831, and there are 38 in Australasia at the present time, 34 of them having assisted in forming the collective institution. The Australasian Association is constituted on the same lines as the British, its specified object being to give a stronger impulse and more systematic direction to scientific enquiry, to promote the intercourse of those who cultivate science in the different colonies among each other and with representatives of science from the outside world, and to secure more general attention to the objects of science and a removal of disadvantages which may impede its progress. The success which has crowned the undertaking is largely due to the efforts of Prof. Liversidge, of the Sydney University, who was an active member of the parent association, and has for some years past been striving to get it duplicated at the Antipodes.

THE scheme for the running of an electric tramway between Newport and Carisbrooke has been the subject of frequent discussion at the meetings of the various public bodies which have any right to express an opinion in reference to the matter. On the question being broached at a recent meeting of the Isle of Wight Highway Commissioners, a resolution was moved by Mr. J. B. Tucker to the effect that permission should be refused on the ground that in the narrow streets of Carisbrooke a railway would be absolutely dangerous. It was contended, on the other side, that to oppose the scheme would be to take a retrograde step, and an amendment was moved that permission should be given for the tramways to be constructed to the base of the hill near Carisbrooke church. By a majority of eight votes, however, the board decided against the proposed tramway *in toto*. On Monday the Court of Quarter Sessions, sitting at Winchester, considered a report in reference to the tramway, which was submitted by Lord Basing, and on its being stated that the local authorities had given their consent, subject to certain restrictions in the borough of Newport, no opposition was offered, subject only to the stipulation that county bridges should be approached to the satisfaction of the Public Works Committee.

MR. HENRY F. JOEL makes out a very good case for himself on the score of the Barnet electric lighting, but his explanation would have carried greater weight a month or more ago. We should, indeed, be pleased to think that he will carry these experiments to a successful issue; but, up the present, it must be admitted that the fates have been somewhat against him, mainly, we imagine, through indiscretion on his own part. We have already seen a portion of the Barnet installation, and shall be glad to take advantage of the first opportunity of going thoroughly over the ground, when Mr. Joel may depend upon it that we shall be ready to give him kudos for any good points he can show us. As we have before pointed out, the system on which he is working is new to this country, and therefore it would be well to allow the time element to come in before hastily deciding either one way or the other.

IT seems more than ever evident that Prof. Van der Weyde is all at sea with his criticisms on Mr. Harold P. Brown's experiments. When a gentleman poses as a critic on any subject it would be well that he should know more of the matter under discussion than does Mr. Van der Weyde of the Cardew voltmeter. His own admissions in the paper which we publish this week are all sufficient to show the generally erratic character of his views, and he would be well advised in future to remember the old adage of "more haste, less speed."

EXCELLENT prospects are now afforded at Bournemouth of substantial progress being effected in connection with the electric lighting scheme, which has been in abeyance for some time past. The negotiations between the Anglo-American Brush Electric Light Corporation, Limited, and the liquidators of the defunct Bournemouth Electric Light and Power Company, have now been finally completed, and it is hoped that the Corporation may be enabled by Christmas to commence an active "plan of campaign." Electric lighting works are to be erected in close proximity to those of the Gas Company, and it is pointed out that as the Brush Corporation has great financial resources at its disposal and manufacture on a very large scale, it will be enabled to provide the electric light on very much more favourable terms than could possibly be expected from a smaller company. As the new undertaking is fully calculated to inspire confidence on the part of the general public, there is reason to believe that a great impetus will be given to electric lighting in this fashionable watering place.

LIEUTENANT MURDOCK, of the United States Navy, has in a recently published volume discussed some very interesting questions relating to the use of the dynamo on shipboard. According to Lieutenant Murdock, in America, when a slow speed dynamo is wanted, it is customary to select the frame of one which nominally has double the required output, and then run it at much less than the normal speed. Yet, as he says, this is not a slow speed dynamo, but a high speed machine at a reduced power. The author gives a table of figures illustrating the difference between European and American dynamos, and the fact is brought out that the highest out-puts are shown by the slow speed machines.

CONSIDERING the network of submarine cables which unite the West Indian islands with one another, and connect them with North, Central and South America, the West Indians should not be in a position to complain of want of communication with the outer world. First of all, we have the West India and Panama Telegraph Company, which, starting at Demerara and touching at Trinidad, joins up the windward and leeward groups, and *viâ* St. Thomas, Puerto Rico, Jamaica and Cuba, places the system in contact with the Cuba Submarine Company's lines, which *via* the south coast of Cuba, give connection with the International Ocean Telegraph Company's cables between Cuba and Florida, where the North American system of land lines is joined. Another of the West India and Panama Company's cables connects Jamaica with Colon on the Isthmus of Panama, where an alternative route to the States and Europe is afforded by the Central and South American Company's cables along the Pacific coast. These cables are connected, by means of a land line across the Isthmus of Tehuantepec, with the Mexican Telegraph Company's cables laid between Goatzocoalcos, Vera Cruz, Tampico and Galveston, joining at the latter place the Western Union system of land lines. Further communication with South America is afforded by the Antilles Cable Company's lines which were recently laid between Cuba, Hayti, Curaçao and Venezuela. In addition to these existing lines there are the proposed cables of the Pedro Segundo Company between Curaçao, Guiana and Brazil, being in effect a continuation under another name of the Antilles Cable Company's system, and the proposed cable between Cuba and Yucatan. It does not appear, however, that these new enterprises, actual and proposed, can be satisfactorily worked until they possess some independent means of communication with the North American land line system, either by a connection, from Cuba, with the Mexican company's cables at Goatzocoalcos or Vera Cruz, or by a direct line from Cuba to some point on the North American coast. We have heard nothing lately of the scheme for connecting either the Azores or the Canary Islands by an Atlantic cable with Cuba. Probably such an undertaking would be beyond the powers of the associations at present interested in competing for West Indian and Central and South American traffic.

THE attendance of members of the Electrical and Allied Trades Section of the London Chamber of Commerce is specially requested at a meeting which will be held at Botolph House, Eastcheap, on Monday, October 22nd, at 3 p.m., for the purpose of completing the organisation of the Section on the lines of the circular letter issued on July 24th last. The following agenda of business will be transacted :—1. To receive and adopt a report from the organising committee with reference to the future working of the Section. 2. To consider the subjects to be dealt with by the Section. 3. Election of the working committee of the Section (result of the voting to be announced). 4. Other matters. As each member of the Section will receive a voting list and a notification of all that has taken place, we need not enter into any further particulars. We would, however, advise care and deliberation in selecting the names for the working committee.

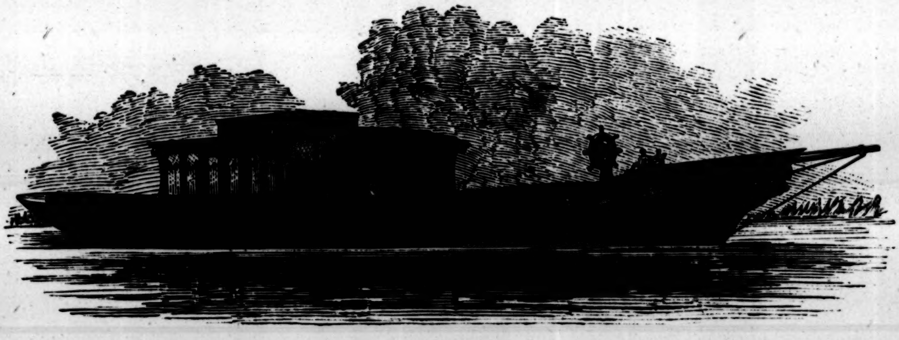
MR. STEPNEY RAWSON has contributed an interesting and important article to the *Gas Engineers' Magazine*. He is a sort of godfather to Mr. Harcourt's pentane standard lamp, and has been making a large number of careful experiments to see how far the standard is reliable. The results of the various tests show the pentane lamp to be a practically perfect standard ; in fact, none of the errors would be observable by an ordinary mortal at all. Mr. Rawson has had much experience in photometry, and practice makes an observer very accurate, but still when an alteration of temperature makes an error of 1 in 2,500, we are astounded at the accuracy with which such observations can be taken. We had a vague idea that photometric observations were good if they agreed within one or two per cent., in fact the average standard candle varies some 20 per cent., and gas engineers are just beginning to question its absolute reliability. The pentane lamp was described in our issue of April 6th, 1888. It is easy to work with, very suitable for the use of lamp makers, as it gives a whiter light than most standards, and Mr. Rawson's careful tests show that it is thoroughly reliable. It is odd that gas analysts should first have to use a candle as a standard and should then advance to a paraffin lamp.

THE hatchet has been buried at Leamington, and an era of cordial agreement has commenced between Messrs. Chamberlain and Hookham and the Town Council. The friendly offices of the Mayor brought about this highly desirable state of things. That functionary had several interviews with the electric lighting firm, and eventually offered to himself provide posts for additional street lamps. Messrs. Chamberlain and Hookham made an amended offer to the council, which, as we stated last week, was accepted, and everything promises well for harmony in the future ; provided, of course, there are no more failures. The electric light is very popular in Leamington—correspondence and articles in the local papers, and the discussions at the Council meetings, have revealed that fact—and we are glad to see that it is being gradually adopted for internal lighting. An application was made at the last meeting of the Council by the Corporation School of Art for a more effective means of lighting the rooms used by the students, and suggesting that the electric light should be introduced, as the connections were in close proximity to the room, and the cost would be small. The matter was referred to the General Purposes Committee, but a general hope was expressed that the request of the School would be acceded to.

THE ELECTRIC LAUNCH "VISCOUNTESS BURY."

THE *Viscountess Bury* was launched from the builder's yard, Strand-on-the-Green, Chiswick, on Monday, October 8th. This is the largest electrical boat which has yet been seen on the Thames, or probably in the world, if we except that of Mr. Elieson. She is intended for public use, and will carry upwards of eighty passengers comfortably.

The *Viscountess Bury* has been specially designed and built for a private company by Mr. W. Sargeant, electrical launch architect and constructor, Chiswick, Middlesex. She is 65½ feet long with 10 feet beam and has a mean draught of 22 inches with a displacement of 12½ tons. The hull is constructed of three skins, the inner being diagonal, and outside planking of bright mahogany in narrow widths. The keel, which runs from stem to taffrail, is in one length of American rock elm. Deadwood aft has been in this instance entirely abandoned, the object being to assist the steering in narrow bends up the River Thames, and for giving a clear run, and to get greater efficiency from the twin three-bladed propellers, which are built up of steel to a 12 inch pitch and 2 feet 3 inches diameter, rotating outwards, and calculated to revolve at 600 revolutions per minute. These propellers are beautifully made and were provided by Messrs. Thornycroft and Co., the well-known torpedo boat builders of Chiswick.



Mr. Sargeant has designed a rudder on an entirely new principle with the object of clearing weeds, obviating stern post dead wood and gudgeons, with facilities for quick removal and easy steering. This rudder will be built up of thin steel, galvanised, and slung in a gun-metal trunk. The steering wheel is situated right forward on the deck, as shown in the illustration, so that the man operating has full view of all small craft which so numerously frequent the higher reaches of the Thames in summer. Adjoining the steering wheel will be an indicator communicating with the electrician in charge of the switches controlling the electrical power.

The electrical energy is stored in 200 Electrical Power Storage Company's accumulators of the "1888" type, each of which has a capacity of 145 ampère hours with a discharge of 1 to 50. The midship section of the vessel being perfectly flat, there will not be any lids to these boxes, so in the event of her taking the ground the acid will not slop over. These storage cells are arranged, one hundred on each side of the vessel, under the seats. The space occupied by them is lined with lead, small drains leading into receivers in case of accident, thus securing perfect dryness for the boxes. The cells are computed to hold electrical energy sufficient with one charge to propel the vessel for 10 hours at a speed of six miles per hour, as regulated by the Thames Conservancy bye-laws. There are two 7-inch "Immisch" motors, which convert the electrical energy into power. These are calculated to develop 7½ break H.P. at 1,000 revolutions per minute. They are placed under the floor aft, each working direct on to one of the twin propeller shafts. The thrust is taken from a ball-bearing thrust block, which reduces the friction greatly. The switches are fixed, port and starboard, and are two to each motor, one for half and full speed, the other for going ahead or astern. They are worked by the electrician in answer to bell signals from the man at the wheel. Each propeller can thus be worked independently of its twin companion, and so greatly assist the steering in sharp bends of the river.

In place of the objectionable whistle of the steamers a large and melodious ship's bell is placed on the cabin top and may be sounded electrically by the man steering, the current coming direct from the accumulators. This bell will sound for warning boats and signalling lock-keepers.

All lights for port, starboard, masthead and cabin lavatories, &c., will be incandescent electric lamps supplied by the accumulators.

Ammeters, voltmeters and suitable resistances are all under the immediate sight or control of the electrician. All the machinery being placed below the floor, leaves a clear space from stem to stern for passengers.

From the illustration it will be seen that the cabin is furnished with a ventilating lantern, and is placed amidships with lavatories, &c. The upholstering is of crimson embossed velvet, the panelling is of moulded teak, bright varnished throughout, the ceiling being moulded and picked out in gold and white. In the centre is the dining table, and seats run all round the cabin, which is 10 feet long with folding flaps on each side.

The windows are of engraved plate glass, and those of the ventilators amber in colour. The fore and aft parts of the vessel are of bright teak and upholstered with portable seats, so that the accumulators may be easily examined in case of necessity, or at the time of charging.

The carving on the bow boards and figure head, which represents the Viscountess Bury, was done in an artistic manner by Mr. David Gibb, of Limehouse.

Mr. Sargeant designed another electrical launch, the *Malden*, which during the past summer was a familiar object of interest on the Thames, especially during the Henley Regatta. The *Malden* is 30½ feet long, with 4 feet 10 inches beam. She was constructed chiefly for experimental purposes, and upon her trials data of great interest have been obtained. On one occasion, with a single charge, the *Malden* was propelled 56 miles down stream at about 10 miles per hour.

This boat was built by Maynards, of Chiswick, under the superintendence of the designer. The propeller is double bladed, 2 feet diameter, by Thornycroft & Co

The motor is a 6-inch "Immisch" machine, driving the propeller at 550 revolutions per minute, from 48 accumulators.

For the convenience of charging these vessels, Mr. Sargeant designed a floating station. In outside appearance it is much like a large "house-boat" of the Thames. It consists of a large river barge, 70 feet long by 14 feet beam. On the floor, upon a suitable foundation, is placed a semi-portable steam engine of 25 H.P. nominally, with counter shafting. This drives dynamos, which through insulated copper leads, supply the current to the accumulators in the launches. There are also on board an instrument room, office, engineer's room, stores and sleeping accommodation aft. This station, which has already been mentioned in the REVIEW, was a conspicuous object at the last Henley and Maidenhead regattas, when among its other duties it lit up the course in the evenings with an arc lamp, incandescent lamps being used on the station for lighting the various rooms.

Electric propulsion for river launches is likely to become an established fact on the Thames, and Mr. Sargeant has other boats in course of design and construction.

REPORTS AND REMARKS ON ACCUMULATORS.*

By DR. A. VON WALTENHOFEN.

IT must be premised that the present memoir consists of three sections. The first contains results of experiments which I carried out partly in Vienna and partly in Schemnitz, with a new accumulator constructed for heavy work by Farbaky and Schenek. In the second section the performances of the accumulators of the Tudor system are compared by Prof. W. Kohlrausch with those of other systems. The third section contains remarks on an abstract of my memoirs (from the *Central Blatt für Elektrotechnik*) which appeared in the Berlin *Elektrotechnische Zeitschrift.*

My memoir of March last, which appeared in the *Central Blatt* contains a preliminary notice of a new Schemnitz accumulator with plates weighing 21·3 kilos, constructed for discharges with 100 a., or five times the normal intensity. It has seven positive and six negative plates (0·6 × 26·0 × 14·5 centimetres) of 3·77 square decimetres surface.

Such an accumulator was sent for examination to the Imperial and Royal Electrotechnical Institute of Vienna, and the investigation was conducted as follows, by myself in concert with Messrs. Frisch, Peukert and Zickler.

In the first place the accumulator completely charged was so far discharged with a current kept as far as possible at the constant strength of 100 a. (mean = 99·55), that the initial polar tension of 1·87 v. was reduced to 1·78 v. This discharge, which lasted 100 minutes, gave a capacity of 165·87 a. hours and 305·02 w. hours, with a reduction of only 4·81 per cent. in the polar tension. The electromotive force at the beginning of the experiment was 2·04 v. and 1·92 v. at the end.

Next the degree of efficiency of the accumulator was determined for the case when the charge is effected with an approximately normal strength of current, but the discharge with as strong a demand as before. It was charged about 20 a. and discharged with 100 a. In order to abbreviate the experiment only a partial charge and a corresponding discharge were undertaken. The accumulator which in the above-mentioned discharge had given out nearly 166 a. hours was charged only with about 100 a. hours and again discharged with a strength of current of 100 a. until the final value come to in the first discharge (178 v.) was again reached. This discharge yielded 88 a. hours, or about 88 per cent. of the charge. For the electrical work there appeared from a comparison of the watt hours received and given off a degree of efficiency of about 77 per cent.

Higher degrees of efficiency would have naturally resulted even with an equally strong demand if the charge had been undertaken still more slowly, *e.g.*, with only 15 a. instead of 20 a.

The entire course of the charges and discharges just described is shown in the following tables I., II., and III.

TABLE I.—DISCHARGE.

No.	Time.	Tension at terminals, Δ	Mean values of Δ	Strength of current, J.	Mean values of J.	Ampère hours.	Watt hours.
	h. m.						
1	8 0	1,870	1,865	100	100	16·66	31·07
2	8 10	1,860	1,864	100	100	16·66	31·05
3	8 20	1,868	1,864	100	100	16·66	31·05
4	8 30	1,860	1,858	100	100	16·66	30·95
5	8 40	1,856	1,851	100	100	16·66	30·84
6	8 50	1,846	1,842	100	100	16·66	30·68
7	9 0	1,838	1,831	100	99·5	16·58	30·35
8	9 10	1,824	1,818	99	99	16·50	30·00
9	9 20	1,812	1,806	99	99	16·50	29·80
10	9 30	1,800	1,790	99	98	16·33	29·23
11	9 40	1,780		97			
Decrease of tension at poles ..		4·81 p. c.			Mean: 99·55	Sum: 165·87	Sum: 305·02

Remark.—At the beginning of the experiment the electromotive force was 2·04 v.; after the discharge 1·924 v.

TABLE II.—CHARGE.

No.	Time.	Tension at terminals, Δ	Mean values of Δ	Strength of current, J.	Mean values of J.	Ampère hours.	Watt hours.
	h. m.						
1	9 45	1,980	2,003	21	20·75	5·19	10·40
2	10 0	2,026	2,038	20·5	20·5	5·12	10·44
3	10 15	2,050	2,058	20·5	20·25	10·13	20·85
4	10 45	2,066	2,060	20·0	20·0	10·00	20·60
5	11 15	2,054	2,054	20·0	19·75	9·88	20·29
6	11 45	2,054	2,071	19·5	19·50	9·75	20·19
7	12 15	2,088	2,090	19·5	19·35	9·67	20·21
8	12 45	2,092	2,093	19·2	19·20	9·60	20·09
9	1 15	2,094	2,093	19·2	19·20	9·60	20·09
10	1 45	2,092	2,088	19·2	19·20	9·60	20·04
11	2 15	2,084	2,085	19·2	19·30	9·65	20·10
12	2 45	2,086	2,086	19·4	19·40	1·62	3·38
13	2 50	2,086		19·4			
						99·81	206·68

Remark.—At the beginning of the charge the electromotive force was 1·924 v.; after the charge 2·034 v.

Soon after the execution of the experiments abovementioned, I had the opportunity of examining such an accumulator in Schemnitz in concert with the director of the Schemnitz Academy, Mining-Councillor Farbaky, and Mining-Councillor Prof. Schenek. The experiments were conducted in the laboratory of the latter savant on July 9th, 10th, and 12th of this year. The weight of the plates in this accumulator was 21 kilos.

Induced by the favourable results of the experiments described above, with a discharge of $\frac{99\cdot55}{21\cdot3} = 4\cdot7$ a. per kilo of plates, and by the experiments of Prof. W. Kohlrausch, who employed with the Tudor accumulators discharges up to $\frac{80\cdot4}{13\cdot6} = 5\cdot9$ a. per kilo of plates, I proposed to Messrs. Farbaky and Schenek to discharge the 21 kilo accumulator in question with 200 a., *i.e.*, with 9·5 a. per kilo of plates, consequently with a demand greater by 61 per cent. than the strongest applied by Prof. Kohlrausch with Tudor accumulators.

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* *Centralblatt für Elektrotechnik.*

TABLE III.—DISCHARGE.

No.	Time.	Tension at terminals, Δ	Mean values of Δ	Strength of current, J.	Mean values of J.	Ampère hours.	Watt hours.
	h. m.						
1	2 55	1,878		101·0			
			1,871		100·75	16·79	31·41
2	3 5	1,864		100·5			
			1,855		100·25	16·71	31·00
3	3 15	1,846		100·0			
			1,834		99·70	16·62	30·49
4	3 25	1,822		99·4			
			1,811		99·10	16·52	28·91
5	3 35	1,800		98·8			
			1,796		98·6	8·22	14·76
6	3 40	1,792		98·4			
			1,791		98·2	8·18	14·65
7	3 45	1,790		98·0			
			1,785		97·9	4·90	8·75
8	3 48	1,780		97·8			
						87·94	159·97
						88·1 per cent.	77·4 per cent.

Remark.—The initial electromotive force of 2·034 v. sunk to 1·900 v.

The regular course of this discharge may be seen in Table IV. The following circumstances must be noted. At 4 p.m. the circuit was closed with a regulating resistance arranged approximately as in the former experiments. The current was then as quickly as possible regulated to 200 a., so that at 4.2 p.m. the readings could begin, and were taken every five minutes. At 4.50 the circuit was broken and the series of experiments concluded. During the entire duration of the experiments (48 minutes) the current was kept constant at 200 a., and, therefore, during this time 160 a. hours were given off by the accumulator. The loss of current during the two minutes spent in regulation must be estimated as at least 6 a. hours. The accumulator consequently showed, during the discharge with 200 a., a capacity of 166 a. hour. The polar tension had sunk from 1·89 v. to 1·40 v.—that is almost 26 per cent. But if it had only been discharged to a decreased polar tension of 10 per cent., *i.e.*, to a tension of 1·70 v., the experiment (as we may find by interpolation) must have been concluded 10·6 minutes earlier, but we still should have obtained from the accumulator a quantity of electricity of nearly 131 a. hours.

TABLE IV.—200 AMPERES.

TIME.	Δ
h. m.	
4 2	1·89
4 7	1·89
4 12	1·88
4 17	1·87
4 22	1·85
4 27	1·81
4 32	1·75
4 37	1·72
4 42	1·66
4 47	1·58
4 50	1·40

But that this extra normal and hitherto unattained discharge had not injured the accumulator may be seen in the following (Table V.), which gives the particulars of a discharge undertaken the following day with a still heavier demand, beginning with 300 a. and continued with a mean of 270 a., after the accumulator had again been charged overnight with a current of 15 a. The experiment lasted 27 minutes. The strength of the current, with a regulating resistance remaining constant, sunk from 301·3 a. to 211·8 a., and the polar tension from 1·84 v. to 1·28 v., *i.e.*, 30·5 per cent. From the mean values of the strength of the current, and the duration of the experiment, it follows that in round numbers about 120 a. hours are given off, disregarding the considerable losses of current in the regulation previous to measurement. Therewith the capacity of the accumulator was by no means exhausted. After a pause of 39 minutes the accumulator was further discharged for about 50 a. during 20 minutes, and thus it was made to yield about 17 a. hours. During this second discharge the polar tension had the initial value of 1·85 v. (the accumulator had recovered during the interval) and the final value 1·26 v.

TABLE V.—301·3 TO 211·8 AMPERES.

TIME.	J	Δ
h. m.		
9 18	301·3	1·84
9 23	299·3	1·81
9 28	291·2	1·75
9 33	282·7	1·70
9 38	265·8	1·59
9 43	228·4	1·40
9 45	211·8	1·28

Whether this latter enormous over-exertion has remained without injurious consequences for the accumulator Messrs. Farbaky and Schenek have not stated. But our experiments carried on in Schemnitz have shown that the 21-kilo. accumulator examined can be discharged with 200 a. without injury, being 9·5 a. per kilo. of the weight of the plates.

The capacity for that part of the discharge which answers to a decline of tension of 10 per cent., amounted to 131 a. hours, or 6·24 a. hours per kilo. of plates. Discharges of 100 a. (*i.e.*, more than 4·7 a. per kilo. of plates) involve such a trifling decrease of the polar tension that this demand can be completely utilised for all practical purposes. But even the demand of 200 a. (9·5 a. per kilo. of plates), though its application may be advisable only in exceptional cases, has a practical value, since as we have seen, it does not involve a fall of tension of 10 per cent. until 131 a. hours (6·24 a. hours per kilo. of plates) have been given off.

The thorough investigation of the Tudor accumulators, or rather a treatise appearing in the form of a professional opinion, has called the attention of specialists to these accumulators, which were previously scarcely known even by name.

A very important point, however, seems to have been hitherto overlooked, the extremely small capacity of the Tudor accumulators. This, even with a feeble discharge current of 6·5 a., therefore $\frac{6\cdot5}{13\cdot6} = 0\cdot48$ a. per kilo. of plates, only 47·7 a. hours, therefore $\frac{47\cdot7}{13\cdot6} = 3\cdot5$ a. hours per kilo of plates. Moreover, in the experiments on which this result is founded, the polar tension had decreased by 12·6 per cent., whilst in determining the capacity admitting of practical utilisation, it is not advisable to go beyond a fall of tension of 10 per cent. If we keep this rule in view, we find the value of the Tudor accumulator small and still smaller if we use stronger discharging currents.

On page 4 of the pamphlet we find mention of an experiment with a discharge current of 14 a. With reference to the weight of the plates of the accumulator (13·6 kilo.), this would about correspond to the normal strength of current of 1 a. per kilo. of plates. In this experiment there resulted a capacity of 33·7 a.

hours, that is, only 2·5 a. hours per kilo. of plates. It is further doubtful whether the decrease of tension in this experiment did not exceed 10 per cent., on which point we find no information. If such was the case, the useful capacity would be still smaller. But even if we assume that this was not the case, the capacity of 2·5 a. hours per 1 kilo. of plates amounts to less than the half of the minimum and one quarter of the maximum of the capacities demonstrated in other good accumulators under similar conditions.

The following example may further serve in explanation :—

We will compare the Tudor and the Schemnitz accumulators as regards the decline of tension which sets in after specific discharges of equal magnitude, *i.e.*, after giving off an equal number of a. hours per kilo. of plates.

On page 4 of Prof. Kohlrausch's professional opinion it is stated that in the Tudor accumulator examined, a production of 20·1 a. hours, therefore of $\frac{20 \cdot 1}{13 \cdot 6} = 1 \cdot 5$ a. hours per kilo. involved a fall of tension from 1·74 v. to 1·30 v., or a proportion of 25·3 per cent. The intensity of the discharge was $\frac{80 \cdot 4}{13 \cdot 6} = 5 \cdot 9$ a. per kilo.

For the new Schemnitz accumulator it appears from Table 4 that the discharge for 10 minutes with a current of 200 a., yielding consequently $\frac{10 \times 200}{60} = 33 \cdot 3$ a. hours, or $\frac{33 \cdot 3}{21} = 1 \cdot 57$ a. hour per kilo., reduced the tension from 1·89 v. to 1·88 v., or only 0·53 per cent. Thereby the intensity of the discharge was far greater than in the former case, namely $\frac{200}{21} = 9 \cdot 5$ a. per kilo.

Another instance : suppose it is required, say, in order to work an electric light installation, that each single cell of the battery of accumulators should yield a current of 160 a. for 6¼ hours (which amounts exactly to 1,000 a. hours), and in such a manner that the fall of tension produced shall not exceed 8 per cent. This is exactly the yield which I obtained with the old Schemnitz accumulators (subsequently much improved) in the year 1886, from experiments on the large scale, with batteries of 56 and 26 cells. The plates of such a cell weigh 170 kilos.

For the Tudor accumulators the normal demand, according to Prof. Kohlrausch (page 1 of his memoir) is 6·5 a. per 13·6 kilos, or 0·48 a. per kilo. On the other hand, we find from the table on page 3 by interpolation that a fall of tension of 8 per cent. corresponds to a discharge of 45 a. hours, or 3·31 a. hours per kilo. Hence 1,000 a. hours require a weight of plates of $\frac{1{,}000}{3 \cdot 31} = 302$ kilos, but which according to the above would only suffice to give a current of $302 \times 0 \cdot 48 = 145$ a. whilst a current of 160 a. is required. Hence it appears that if it were required to substitute a Tudor accumulator for a Farbaky-Schenek accumulator of the old construction, nearly double the weight of plates would be required. The comparison would be still less favourable with Farbaky and Schenek's new accumulators, as can be easily learnt from the treatises of Huber, Reckenzaun and Julien, as well as from my own memoirs.

The main advantage of the Tudor accumulators examined by Prof. W. Kohlrausch would be, in my opinion, that they were obtained with a battery which, according to the written and verbal statements of Henri and Hubert Tudor, has been in uninterrupted daily use for six years. But latterly papers have appeared in electro-technical journals which very decidedly call the accuracy of this statement in question, and seek to limit the duration of the battery in question to about one year, so that it is still doubtful if the Tudor accumulators equal the others in their durability.

We must await the decision of this dispute and confine ourselves to the publication of the above experiments which demonstrate the power of the new Schemnitz accumulators to meet demands which have hitherto been never attained.

The following remark must be made concerning the degree of efficiency. In Prof. Kohlrausch's pamphlet (page 5) the degree of efficacy for the Tudor accumulators has been found 94 per cent. as regards the ampère hours, and 82·4 per cent. as regards the watt hours (especially considering the intervening times of rest) and is pronounced unusually high.

To this I must make the following objection :—The values which we obtain in examining the capacity and the degree of efficacy of an accumulator depend to a great extent on the currents used in charging and discharging, and come out higher when small demands are made upon the apparatus. The values obtained for the Tudor accumulators have been obtained with unusually small strengths of current, namely, 5·0 a. for charging and 6·5 a. for discharging, the demand being respectively 0·37 and 0·48 a. per kilo of plates, whilst, as a rule, a doubly greater demand is made upon accumulators. This applies especially to my experiments on other accumulators, which showed the degree of efficiency as about 90 per cent. for the ampère hour and 80 per cent. for the watt hour.

If among the experiments which have been made with the Tudor accumulators, we consider those in which approximately equal demands have been made upon the apparatus, we find (p. 4 of the pamphlet) degrees of efficacy indicated which fall more than 10 per cent. below those obtained with other good accumulators.

I subjoin a tabular view of the relations discussed.

TABLE VI.

Name of the accumulator.	Discharge current.	Capacity.	Fall of tension.	Degree of efficiency.	
	Per kilo of plates.	Per kilo of plates.		Ampère hours.	Watt hours.
			Per cent.	Per cent.	Per cent.
Farbaky-Schenek (old type)	$\frac{160}{170} = 0 \cdot 94$	$\frac{1000}{170} = 6$	8	91	78·5
Reckenzaun	$\frac{19}{23 \cdot 9} = 0 \cdot 8$	$\frac{216}{23 \cdot 9} = 9$	7	89·3	80·85
Julien ...	$\frac{10 \cdot 15}{10 \cdot 9} = 0 \cdot 93$	$\frac{100}{10 \cdot 9} = 9 \cdot 2$	ca. 7	89·7	83·4
Tudor ...	$\frac{10}{13 \cdot 6} = 0 \cdot 73$	$\frac{39 \cdot 7}{13 \cdot 6} = 2 \cdot 9$	not known	79·4	68·6
	$\frac{14}{13 \cdot 6} = 1 \cdot 03$	$\frac{33 \cdot 7}{13 \cdot 6} = 2 \cdot 5$		77·0	64·7

The new type of the Schemnitz accumulators give much better results than the old construction, as it will appear from Tables I.—III. Nevertheless, I have given in Table VI. the figures referring to the old type, because they have been obtained from work on the large scale, and not from laboratory experiments with single cells.

In Part 11 (1888) of the *Berlin Elektrotechn. Zeitschrift*, is an article from the pen of H. Th. Schwartze, entitled, "Results of Recent Experiments with different Types of Accumulators."

This article treats also on my memoir on the accumulators of Farbaky and Schenek, of Reckenzaun and Julien, which appeared in the *Central Blatt* (1888, p. 158), and has been repeatedly mentioned in the present paper. It contains, however, such errors, that I cannot refrain from referring to them.

On p. 277 of the extract in the *Elektrotechn. Zeitschrift*, it is said of me : "As with reference to a critique of the experiments made by different experts with the E.P.S. accumulators, Dr. A. von W. arrived at the following relations." This seems to be an invention, for in my memoir to which the extract refers there is no mention of experiments made by different observers with the E.P.S. accumulators, and still less of a criticism of such results. I merely said that the volume for 1888 of the *Electricians' Directory* contains new data referring to the E.P.S. accumulators collated in a table from which noteworthy numerical relations may be deduced, which I have accordingly given in the form of five rules.

The last of these runs :—"The intensity of the discharge, reduced to 1 kilo. total weight, amount for L to about 1 watt, and for S 1·5 to 2 watt." In the extract this sentence is distorted by putting for "watt" "volt-ampère hours."

After these rules there follows in my memoir the statement that for permanent lighting installations the type L comes into use for 100-volt lamps in batteries of 53 elements, which in the extract is modified into 50.

It is further said at the close of the extract :—"On the contrary, with the accumulators of Farbaky and Schenek, with a fall of tension of 15 per cent. there resulted a capacity of 22 ampère-hours" (*i.e.*, per kilo. of plates). This statement is also erroneous in one essential point. Farbaky and Schenek, in the excessive discharge mentioned by me of 22 ampère-hours per kilo. of plates, did not measure the fall of tension, as they had not at that time any suitable instrument at their disposal. Further, the fall of tension for so exhaustive a discharge would doubtless amount to much more than 15 per cent.

I have been obliged to mention all this expressly, as the "Rectification" inserted in the *Elektrotechn. Zeitschrift* has turned out so that the reader may suppose the inaccuracies of the extract were originally present in my memoir, which is not the case. The memoir is perfectly accurate, one word only requiring correction, that is, in one instance I wrote instead of "proportion of acid," "density of acid," an error which every reader acquainted with the subject will be able to correct on reference to the context. In the section on maximum capacity the rule there given must read :—"The discharge must be continued only until the proportion of acid has decreased by one-third, which is further explained in the following section by a numerical example.

A SYNTHETIC STUDY OF DYNAMO MACHINES.

(*Continued from page* 370.)

II.—LAWS OF INDUCED E.M.F.—(*Continued.*)

The E.M.F. which is induced by cutting the lines of the field has been called the *impressed E.M.F.*, that due to self-induction having been already spoken of as the *back E.M.F.* When the former is constant the current flowing suffers no change, and the number of the self-induced lines remaining unchanged in consequence, no back E.M.F. is produced. But the impressed E.M.Fs. we have been considering are not constant but alternating in direction, the change taking place abruptly, as shown by fig. 33,* or gradually, as exhibited by the simple harmonic curve in fig. 30.* The current induced in these cases is of course alternating in direction, and varies in magnitude from moment to moment. Every change in the current produces a change in the number of self-induced lines, and so varies the back E.M.F., while every variation in the latter again modifies the current.

Very frequently it is stated that alternating currents do not follow Ohm's law, a statement which often proves misleading. In paragraph 6 we assumed that the current at any instant was given by $\frac{E}{R}$, an assumption which would be true if E, the impressed E.M.F., were constant. But where E varies the E.M.F. available for sending a current through the coil is at any instant $E - E_1$, where E_1 is the back E.M.F. due to self-induction, and the current is therefore equal to $\frac{E - E_1}{R}$. It is true that the impressed E.M.F. divided by the resistance will not give the current, but this is simply because E does not accurately represent the E.M.F. urging the current through the circuit. The current is due to the difference between the impressed and back E.M.Fs., and seems to disobey Ohm's law, but the reason for this seeming discrepancy lies in the fact that the *resultant E.M.F.* is less than the apparent E.M.F. Considering the current as caused by the impressed E.M.F. only, we might say that Ohm's law does not hold, but considering it as due to the resultant of the impressed and back E.M.Fs.—and this is the proper way to consider it—we find that Ohm's law must be necessarily true however the current may vary.

The back E.M.F. is at any moment proportional to the rate of rise or fall in the current, or, in other words, to the rate of change in the number of self-induced lines enclosed by the coil. Taking the diagram, fig. 33,* which represents the E.M.F. impressed on a frame by moving it in an intermittent field, we may graphically represent the effect of self-induction when a current flows in the frame by the curve in fig. 34.

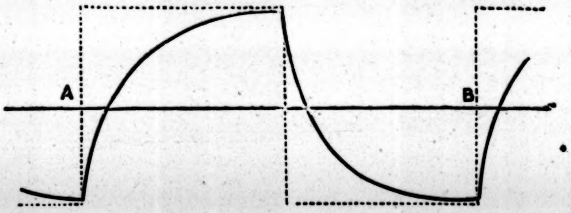

FIG. 34.

If there were no self-induction the current would reach a maximum value of $\frac{E}{R}$ simultaneously with the impressed E.M.F., as shown by the dotted line, but self-induction prevents it from rising abruptly and from attaining this strength, its actual rise and decline being represented by the curved full line. This line also represents the rise in the resultant E.M.F., the difference between the ordinates to the curve and the ordinates to the dotted lines representing the back E.M.F. The latter, as will be seen, is proportional at any moment to the rate at which the current is growing, this being represented by the slope of the curve.

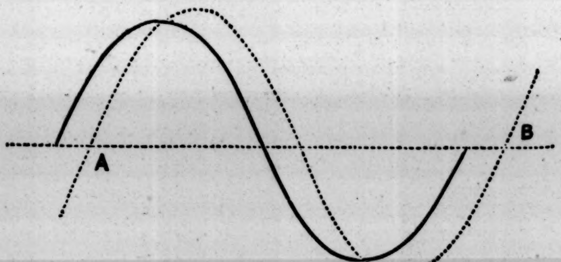

FIG. 35.

When the impressed E.M.F. is a curve of sines as represented by the dotted line in fig. 35, the effect of self-induction is to cause the resultant to lag behind the impressed E.M.F., as shown by the full line. This resultant $= E - E_1$, call it E_2, is the E.M.F. producing the current, the latter being at any instant as before stated = $\frac{E - E_1}{R}$. In designing a machine we know what resultant E.M.F. and current we require, and bearing these in mind as results to be obtained, the question arises—What must be the magnitude of the E.M.F. impressed on the coil?

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* See issue of 5th October, 1888.

* See issue of 5th October, 1888.

From paragraph 10 we learn that the average E.M.F. produced in a rotating frame, excluding self-induction, is = $\frac{4 N n}{10^8}$ volts. If we call the resultant lines of force, to the cutting of which E_2 is due, p, we get the average value of E_2 in volts as $\frac{4 p n}{10^8}$ and its value at any instant = $\frac{2 \pi p n (\sin \phi)}{10^8}$. Here ϕ is the angle through which the frame has moved from the position where E_2 is nought and the current reverses. Construct a curve of sines, A, B, C, D, E, fig. 36, where the maximum value of the ordinates is $\frac{2 \pi p n}{10^8}$, a cycle being represented by the distance, A, E. This curve will represent the resultant E.M.F. Now we know that the back E.M.F., E_1, is proportional to the rate of change in the current, or what amounts to the same thing, the rate of change in E_2. Evidently this is a maximum at A, C and E, and nought at B and D. The lines induced by the frame on itself keep pace with the current, and the maximum number which can be induced we will call q. It will be seen that E_1 is nought when q is a maximum, and that conversely E_1 is a maximum when q is nought. E_1 can be expressed by a curve of sines whose maximum ordinate is $\frac{2 \pi q n}{10^8}$, its value at any moment being $\frac{2 \pi q n (\cos \phi)}{10^8}$. We now proceed to construct the curve, a, c, e, a curve of sines of the same period as A, B, C, D, E, having its maximum ordinate = $\frac{2 \pi q n}{10^8}$, and displaced one-quarter cycle from the current curve as shown. This curve represents, E_1, the back E.M.F. of self-induction. The impressed E.M.F. must be equal to $E_1 + E_2$, and by adding together the ordinates of these two curves, we obtain for E the curve a, B, c, D, e, as shown by the dotted line. The maximum value of E can be measured from the diagram by scale, it is = $\frac{2 \pi N n}{10^8}$, and the number of lines of force, N, required for the induction = $\frac{E_{\max} 10^8}{2 \pi n}$.

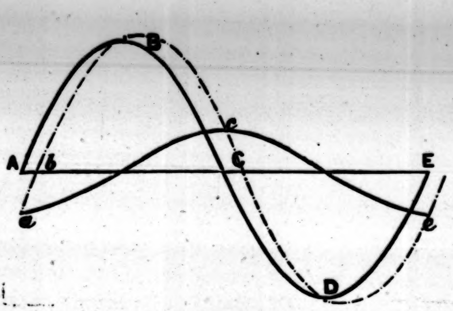


Fig 36.

Having constructed the curve to represent E, we are able to see more clearly the effect produced by self-induction. We notice first that E_2 is caused to lag behind E by a certain angle represented by the length, A, b. Next we notice that the ordinates of E_2 are shorter than ordinates of E, a fact at once understood from the consideration that, p, the lines of force to which E_2 is due, are the resultant of N and q, and q always opposes N. Looking at the equation for the value of E_1, we see that the speed, n, and the number of lines, q, are the factors upon which its magnitude depends. If the speed is reduced the ordinates of E_1 will be shortened, the angle of lag consequently diminished, and the impressed E.M.F. lessened, or looking at it another way, the resultant E.M.F. will approach more closely to the impressed E.M.F. as self-induction is diminished, and the output will be in consequence increased. The other factor, q, depends upon a number of things, such as the shape and size of the coil, and it will be seen that its reduction has the effect of reducing the ordinates and also diminishing the angle of lag. We have considered the case of a simple frame, but in a coil of several convolutions the number of self-induced lines will be proportional to the convolutions. It is obvious, therefore, that the self-induction can be made very small, and its effects almost negligible by reducing the turns on the moving coils. But to do this and still maintain the E.M.F., the field must be made much stronger, and this point we shall consider by-and-bye.

Now from the above it seems very easy to determine N, having already settled what shape the current curve is to have and having decided the exact geometry of the field. We can say, given a uniform field with a frame spinning in it, the impressed E.M.F. will be a curve of sines capable of resolution into two curves of similar character differing in phase by an angle of 90°. One of these curves will represent the resultant E.M.F. and the other the back E.M.F. Having settled the dimensions of the former we can, knowing q, draw the latter, when the sum of the two will give the impressed E.M.F. But it so happens that in dynamo machines we have no uniform field, no simple frame set spinning in the field, no curve of sines, and no method by which we can predetermine the effect of self-induction. In future articles we shall see that in actual machines one uniform field may be replaced by a number of fields by no means uniform. We shall find that instead of a single turn of wire we have coils consisting of many turns and having in some machines iron cores. We may notice that sometimes in machines having coreless coils, the impressed E.M.F. accidentally approaches a curve of sines, though no one yet knows the form of E or E_2 in a machine having iron cores. Lastly, we shall find that the effect of self-induction is, like many other things unluckily for us, indeterminate until the machine is made. But we must do our best with the data at our disposal. We are dealing with synthesis not with analysis, and keeping in view certain results to be obtained, our object is to piece together, as far as we can, a machine which will yield those results.

III.—The Dynamo Defined.

13. It was stated in paragraph 6 that the induction of an electric current necessitated the expenditure of a certain amount of power, an inexorable law of nature demanding that the electrical energy appearing in the circuit should be equal to the mechanical energy expended in moving the coils. In actual machines we have to do rather more than move coils, there being a certain amount of energy wasted in overcoming the friction of bearings, and in other sources of loss to be considered hereafter. In good machines, however, the energy appearing electrically is a high percentage of the mechanical energy given to the pulley. In every case of movement in the magnetic field we have had an example of the mechanical production of electric currents, and it will be obvious to the reader that as long as we have relative motion producing a change in the lines of force enclosed by the conductors, it is quite immaterial whether (a) the conductors are moved across the field, (b) the fields are moved across the conductors, or (c) both are moved together. We may define a dynamo then as *a machine designed to transform mechanical into electrical energy by the continuous relative motion of a conductor and magnetic field causing periodic variation in the number of lines of force enclosed by the conductor.*

Every dynamo machine consists of two parts, the magnet or magnets producing the field—in almost all cases electro-magnets—and the conductor in which the current is induced, called the armature. In all types motion is given to a revolving spindle and to this is attached the armature or field magnets as the case may be.

In part II. we considered the performance of the moving coils as divided into cycles, and found that in a cycle each coil had two currents in opposite directions induced in it. What is true for these coils is true for every element of the conductor in the armatures of practical machines. Considering any little piece by itself, there are induced in it two currents in every cycle; that is between every two positions in which the E.M.F. being *nil*, the little piece is in a similar condition as regards the lines of force. Though, as in many dynamos, the current outside the machine, and in the armature as a whole, may flow quite steadily and always in the same direction, in each element of the latter considered by itself the current must necessarily be alternating with the result that two opposite currents are induced in each element as it performs a cycle.

In treating dynamos we shall classify them primarily according to the character of the current produced in the part of the circuit exterior to themselves. We have, therefore, the three classes following:—

1. *Dynamos producing currents alternating in direction which are necessarily discontinuous.*

2. *Dynamos producing currents in the same direction which though continuous are of an oscillating or pulsating character.*

3. *Dynamos producing currents in the same direction of steady flow.*

The dynamo and the part of the circuit external to it form a closed conductor, the armature of the machine being that part of the conductor which by moving in a magnetic field creates the E.M.F., causing a current to flow. In the case of class 1 machines working on to transformers, it is necessary to consider the dynamo and circuit as a combination producing together the result, but generally speaking the influence of anything other than resistance in the circuit, outside dynamos of classes 2 and 3, may be neglected.

(*To be continued.*)

A PRACTICAL CONCEPTION OF THE ELECTRIC FIELD.

By JOHN GRAY, B.Sc.

THE non-mathematical student of electricity has always had great difficulty in getting a clear conception of the various electrical magnitudes and their relations to one another. He may have at his fingers'-ends the mathematician's definition, say, of potential of a point—viz., the amount of work done on a unit of electricity in bringing it from an infinite distance to the given point, &c., and yet have such hazy notions on the subject as to be unable to explain simple electrical phenomena, such as the well-known fact that points fixed on an electrified conductor will discharge it, though they are at the *same potential* as the flatter parts of its surface from which no discharge takes place. The distinction between potential and electromotive force, and between quantity, density, and capacity, may be cited as a few more of the difficulties he will meet with in the study of this subject. These difficulties may be greatly diminished, if not entirely removed, by forming a mental representation of a physical condition of the dielectric medium, which will account for the results of experiment: but, in framing it, we must be on our guard against allowing it to prepossess our minds as to what may be the complete ultimate explanation.

According to modern views electric forces on bodies are accounted for by the action of a medium called the *dielectric*, in which the bodies acted upon are immersed; the theory of action at a distance being now considered untenable. Our object is to picture such a structure of this medium as will account for observed electrical phenomena, and point out what corresponds to electric potential, quantity, capacity, and other electric magnitudes.

It will be advisable, in the first place, to describe the method of subdividing the electric field by means of tubes of force and equi-potential surfaces employed by Faraday, Maxwell, and others.

A *line of force* is a line drawn in the electric field, whose tangent at any point indicates the direction in which the electric force acts upon an electrified particle placed at that point.

If we suppose that an insulated electrified spherical conductor is placed at the centre of a spherical room, an electric field is formed in the air space between the conductor and the walls of the chamber. In this case radial lines drawn from the centre of the conductor to the walls of the chamber will represent lines of force. If the surface of the sphere be subdivided into a number of small areas of such size that each of such units of area contains a unit quantity of electrification, and lines of force be drawn from every point of the periphery of the unit area, a *tube of force* will be produced. The number of tubes of force will evidently denote quantity of electrification on the surfaces which they cut.

The potential of the conductor we will assume to be higher than that of the surrounding space. Let a number of surfaces be drawn in the electric field, such that every point in a given surface is at the same potential, and the potential of each differs from that of the surface next to it by one unit, these surfaces will cut the tubes of force at right angles, and the whole field will be divided up into small cells, between the ends of which there will be a difference of one unit of potential, and on the ends of which there will be a unit quantity of electrification. These surfaces are called equi-potential surfaces.

In the case we have assumed the tubes of force will be conical, and the equi-potential surfaces will be spheres concentric with the spherical conductors; with less symmetrical arrangements the shape and dimensions of the tubes of force and equi-potential surfaces will be less regular. Each of the *electric cells* contains one unit of the total energy in the electric field, and the number of the cells will denote the total amount of energy, or work stored up in the electric field.

We are now in a position to form a picture of a structure of the electric field which will account for the observed phenomena of statical electricity. Imagine the tubes of force to be material elastic tubes. Across each of these tubes are fixed a number of elastic diaphragms, each diaphragm coinciding with the equipotential plane where it cuts the tube. The mathematical electric cells are now material cells with elastic walls; the sides of the tubes are however supported by the adjacent tubes, so that only the elastic diaphragms or ends of cells can be displaced. Each of these cells is now to be filled with an incompressible fluid, and the structure of our dielectric medium is complete. The incompressible fluid corresponds to what we call *electricity*, which, however, must be carefully distinguished from *electrification*, which is the electricity displaced at the terminal surfaces or poles of the electric field when under the influence of electrical stress. This electrical fluid or electricity would appear not to be the luminiferous ether, but some fluid of a higher degree of tenuity. The substance of the elastic tubes and diaphragms would appear to correspond to a combination of the dielectric substance or material with the luminiferous ether.

A *dielectric* or *insulator*, as we have seen, is a substance in which electricity is capable of receiving a small displacement, but does not permit of its free passage except by rupture of its elastic diaphragms. A *conductor*, on the other hand, is a body in which their are no elastic diaphragms, or if there are any, they have so weak an elastic resistance as to allow the electric fluid to pass through the body with little or no resistance.

The insulated electrified spherical conductor is filled with the electric fluid which can flow freely through any part of its substance. According to the principles of hydrostatics, the pressure of the electricity at all points in the conductor will be the same. It is proved by experiment that the potential, at any point inside or on the surface of a conductor, is the same, hence we naturally assume that potential corresponds to pressure in our hypothetical electric fluid. The further development of the theory will be found to support this view.

Potential.

Assuming that potential is the pressure of the electric fluid, or electricity in the elastic cell as just described, we will endeavour to establish a few propositions about it. We will consider the mechanical laws which govern the changes, in the first place, of a single electric cell. The relation between the distortion or amount of bending produced in an elastic body by a force applied to it is regulated by a well known law called Hooke's law, which stated shortly is :—*The distortion produced in an elastic body is proportional to the force which produces it.* We have a good example in the common spring balance. If one pound stretches the spiral spring one inch, two pounds will stretch it two inches, and so on.

Let A (fig. 1) be a cylinder in which is fitted a piston, B, whose area is one square inch. The piston, B, works without friction, but is connected to a crossbar, D, on the top of the cylinder by a spiral spring, C. Now suppose that this cylinder is immersed in an ocean of incompressible fluid, and that through the opening, E, in the side liquid, is pumped into cylinder. The spring will be compressed by the rise of the piston, and the movement of the piston will be a measure of the difference of pressure per square inch between the fluid inside the cylinder and the fluid outside the cylinder. The amount of work done in forcing the liquid into the cylinder will be equal to the displacement of the piston, multiplied by the average pressure, *i.e.*, half the final pressure, as the pressure starts from zero, and increases uniformly to its maximum. This will be found to be a useful proposition for calculating the amount of energy stored up in the dielectric.

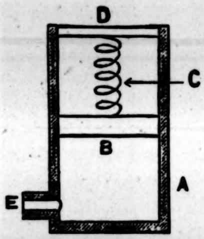


FIG. 1.

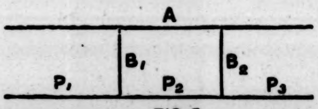


FIG. 2.

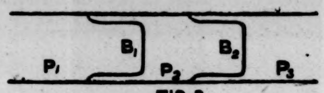


FIG. 3.

If in investigating the laws of potential in any case we require a cylinder with a piston of larger area we are to consider it made up of the required number of these unit cylinders, each square inch of area having its spiral spring of uniform strength. On this assumption, a given difference of pressure per square inch on the opposite sides of the piston will always produce the same displacement of the piston whatever its area. The strength of the unit spring will be the elasticity of the piston or diaphragm.

We are now in a position to describe the unit electric cell.

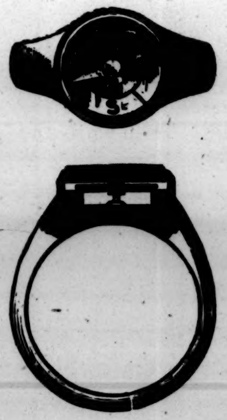
Let A, A (fig. 2) represent the sides of the tube of force, B^1, B^2, elastic diaphragms diagrammatically representing the pistons supported by a spiral spring on each square inch, as already described, and coinciding with the equi-potential surfaces. Now let us suppose that the pressure at P^1 is greater than the pressure at P^3; the diaphragms will be displaced as represented diagrammatically at fig. 3. The fluid between the diaphragms, B^1 and B^2, being incompressible, the displacement of B^2 must be equal to that of B^1. The pressure in the cell $P^2 = P -$ the elastic force of B^1. $P^3 = P^2 -$ elastic force of B^2. Thus we see that the pressure in each cell is less than that in the one preceding it, by the elastic force of the diaphragm which separates them. The potential at any point in an electric field or strained dielectric is the pressure in the electric cell surrounding that point. It may be well to explain here that the elementary electric cell, or what corresponds to it, is probably of exceeding smallness, and it may be assumed that the unit cell which we have found it convenient to use for the purpose of mathematical investigation, is made up of a very large number of these.

A *conductor*, as we have already explained, is a body through which the electric fluid can flow with little or no obstruction. Its bounding surface will be the first skin of elastic diaphragms in the dielectric surrounding it. The conductor may therefore be looked upon as an elastic bag filled with the electric fluid. If a conductor should be brought into such a position as to enclose any number of cells of a dielectric, the pressure of the fluid in all the cells enclosed will be equal, though formerly unequal, because the fluid can now flow freely from one to the other.

(*To be continued.*)

A NOVEL ELECTRIC CURRENT INDICATOR.

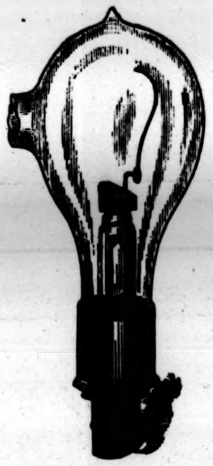
Persons in charge of electric light stations, and especially line men, frequently have occasion to determine whether wires which they are handling carry current or not ; in other words, whether they are "dead" or "live," and as there is no handy method of determining this ordinarily, some simple means of doing so is of considerable value in many cases. To meet this want Mr. Patrick B. Delany, the *Electrical World* states, has



recently devised a simple arrangement, in the shape of a ring which is worn by the operator, and which contains a small compass needle, shown in the accompanying illustration. By placing the ring in proximity to a wire the deflection of the needle will at once show whether the wire be carrying current or not. Another method consists in filling the bezel of the ring with iron filings, the attraction of which by the action of the current also serves to show the presence of the same.

PECULIAR BREAKAGE OF AN INCANDESCENT LAMP.

THE illustration shows a lamp which has been brought to the notice of the *Electrical World*, by Mr. C. G. Young, superintendent of the Mount Morris Electric Light Company, New York City. It is a series Schuyler lamp, and was used in the company's station A. It was designed to run on a current of 9·7 ampères, and was of 50 C.P., with a voltage of 13. It had been running about 100 or 125 hours and gave no signs of weakening, when the filament suddenly broke and the glass blew out as shown, instead of blowing in. It will be remembered that we have previously alluded to a Bernstein series lamp in which the rupture of the filament caused a blowing in of the glass, and an Edison in which it caused a blowing out and protrusions of the bulb.

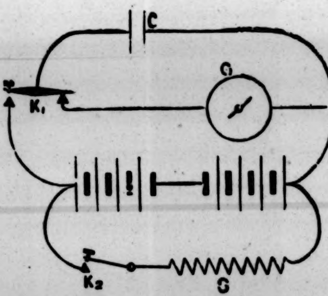


CALCULATING THE INTERNAL RESISTANCE OF A STORAGE BATTERY.*

By J. D. DALLAS.

THE following is a good method, if not a new one, of calculating the internal resistance of a secondary battery :—

By preference take an odd number of cells, n; arrange these so that $\frac{n+1}{2}$ are in opposition to the other $\frac{n-1}{2}$ cells. Then while the internal resistance is that of the whole number of cells, the E.M.F. is that of one. Take, say, 33 cells, an ordinary series for 60-volt lamps ; then join up 16 in opposition to the other 17. Connect up these cells as shown in the accompanying diagram and known as Kempe's test, where C is a condenser, K_1 and K_2 two keys, G a galvanometer, and S a shunt of a suitable resistance.



Two reading are now taken. The first, D, which is the throw produced on the galvanometer when K_1 is let up after having been depressed. The second, d, obtained by first depressing K_2, then K_1, and then letting the two keys up. Calling R the internal resistance of the whole battery, we have :

$$\frac{S}{R+S} = \frac{d}{D}\,;\ \text{or } R = S \times \frac{D-d}{d}.$$

The best condition for taking the test is when $D = 3d$. The galvanometer should, by preference, be ballistic, although any other form of instrument may be ussed. If the throw, D, be too great, place the two condensers in series.

The difficulty always encountered in measuring the internal resistance of a secondary cell is, that the E.M.F. is very high and the internal resistance very small.

THE COPPER VOLTAMETER.*

By LIEUT. G. L. ANDERSON.

WHEN ordinary care is taken, copper electrolysis affords the means of standardising current measuring instruments with great accuracy. The limit of error need not exceed $\frac{1}{20}$th of 1 per cent., which is far within practical requirements. Results in still closer agreement can, no doubt, be obtained by the silver process, but the copper voltameter requires less skill and labour in manipulation, costs less to purchase and use, and it is sufficiently accurate through a greater range of current strength, current density, density of solution, and temperature.

It consists briefly of two series of parallel copper plates suspended vertically in copper sulphate solution. If a uniform current be sent through the solution from the plates of one series to those of the other, the weight in grammes of copper deposited on the latter in one second divided by ·0003287 will, if the requirements are fulfilled, be the strength of the current in ampères and the value of the deflection of a galvanometer in the circuit. The divisor will differ slightly from ·0003287 if the temperature or current density vary much from the normal.

For currents less than five ampères the ordinary cylindrical battery jar may contain the solution and support on its rim rectangular cross-pieces, each having a brass spring or wire clip bearing at the middle for holding a plate. Or the plates may suspend from the cover. Three plates—two, anode and one, cathode—are each cut from rolled sheet of pure hard copper into a circular or rectangular form, having a tongue piece (3 × 2 cms.). The edges and the corners, if any, are rounded off and smoothed. Usually the cathode is two or three centimetres longer and wider than either anode, and should be as thin as possible, and yet sufficiently stiff so as not to be bent in cleaning. The tongue piece projects from the middle of a side of the plate, and in position is held by the spring on the cross-piece. It is the only part of the plate above the surface of the liquid. The cathode is suspended between the anodes parallel at about a centimetre distance, and insulated from them.

For large currents the size or the number of the plates may be increased. If the latter, there will be one more plate in the anode than in the cathode ; the plates of one will alternate with those of the other, and will be insulated from them as above. The Germans use platinum for the cathode, and the results obtained with it agree with those from copper to within $\frac{1}{5000}$th.

The cleaning of the plates prior to immersion, and the washing subsequent to it, are important operations requiring only a short time if properly done. The cleaning consists in polishing the surface with fine, clean, dry sand paper, which is wrapped about a wooden cylinder and revolved in the lathe. The plate is held tightly against the cylinder by means of a pad to avoid touching the surface of the plate with the fingers. The dust is then wiped off with a soft brush or silk pad, or washed off in clean water. If slight oxide remains, as shown by the colouring, the plate is put in slightly acidulated water. If thickly oxidised, as with new copper, it is wetted and placed a few seconds in strong nitric acid, then washed under the spigot and, in order to prevent oxidation, put in a tray to which a few drops of acid have been added. The anode is first suspended in the bath. The cathode is rinsed off and dried, first between two sheets of filter paper, and, afterwards, by a current or before a fire or lamp (not over them). When cooled to the temperature of the air it is weighed and at once suspended in the solution.

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* *Electrical World.*

* New York *Electrical Engineer.*

As soon as the deposit is made the plates are removed, washed in pure water slightly acidulated, and placed in a tray of distilled water. The deposit on the cathode ought to be firm and even, but if there are any crystals projecting care must be taken not to knock them off in washing. This plate is immediately rinsed, dried as before, and when cool weighed. The gain of metal should exceed a gramme.

Special care is taken in cleaning and washing the cathode, which is the only plate weighed. The loss of weight by the anode is usually greater than the gain by the cathode, the difference going to strengthen the solution. Unfortunately the loss is too irregular to be used even as a check.

The solution should be of pure, or good, commercial copper sulphate, free from iron, and have a density anywhere between 1·08 and 1·18. Three to five parts by volume of concentrated solution (density, 1·21), to one of clean water are recommended, with one per cent. sulphuric acid added if the solution is not sufficiently acid from the salt. There should be three cubic centimetres of liquid for every square centimetre of surface —counting one side of all the plates—and it may be used ten hours before throwing away. If the density is much less than 1·08 the deposit is less adherent, and if greater than 1·18 there is danger of the solution becoming saturated, causing, in the first place, oxidation which increases the gain of the cathode, and, secondly, the formation of sharp crystals at the edges.

The solution must be kept distinctly acid to retard its action on the plates. It is found that copper metal in the sulphate solution loses, and, sometimes by oxidation, gains weight in an irregular way. The action appears to be greater when a current is passing; it is slightly less for densities between 1·10 and 1·15, but never wholly ceases, and with acid present it may amount to $\frac{1}{200}$th of a milligramme per square centimetre per hour. The error from this source will not exceed $\frac{1}{30}$th of one per cent. The objections made against the copper voltameter have been this uncertain loss of plate in the solution, and its tendency to oxidise after it is withdrawn and before it is weighed.

The results of many experiments indicate the best size of cathode to be that which presents about 100 square centimetres to every two ampères, or at that rate. In other words, the current density should be about ·02. It may be as high as ·02½, but if it much exceeds this figure there is liability of sharp crystals forming on the edges after 20 or 30 minutes, a weakening of the solution next the anodes and fluctuation of current from temporary polarisation. With diminished current, as low as ·003, the deposit is firm and even, but slightly less than it ought to be. It may, therefore, be used if we take a number smaller than the electro-chemical equivalent for a divisor, as shown in the table. The objection to small current density is that it increases the relative amount of error due to the action of the solution on the plates, leakage between the plates, oxidation of deposit after its removal from the bath, errors of weighing, and so on.

Increase of temperature is likewise found to diminish the proper gain of weight by the cathode, and correction is made as above by taking a smaller number for the equivalent from the table. The effect is slight for changes at ordinary temperatures and greater at 30° or 35° C.

The rule for getting the current strength in ampères, then, is to divide the weight in grammes deposited in one second of time by ·0003287 when the density of the solution is between 1·08 and 1·18, the current density about ·02 and the temperature about 12° C. For other densities and temperatures take the divisor from the following table, given by Mr. Thomas Gray, to whom and to Dr. Kittler we are indebted for the development of the copper voltameter as a means of calibrating current measuring instruments :—

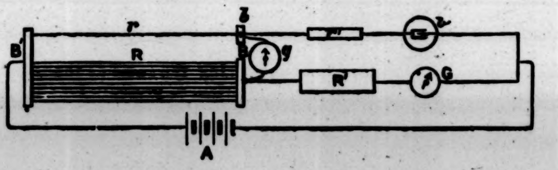
TABLE.

Sq. cms. of cathode per ampère.	Current density.	2° C.	12° C.	23° C.	28° C.	35° C.
50	·02	·0003288	·0003287	·0003286	·0003286	·0003282
100	·01	8	84	83	81	74
150	·006⅔	7	81	80	78	67
200	·005	5	79	77	74	59
250	·004	3	78	75	68	52
300	·003	2	78	72	62	45

If the voltameter is suited to the current strength, or can be adjusted to it by changing the size or number of plates, it is joined in simple series circuit with the galvanometer to be calibrated, a mercury key, a small extra resistance, and a constant battery. The extra resistance, which may consist of a strand of wire on two rollers, as in the Thomson pattern, or of this rheostat joined in parallel with a few coils, is intended to keep the current uniform by more or less of it being thrown in or removed from the circuit. If the current is small, tray cells in series furnishes a steady current, and a high electromotive force is desirable. In case of large currents, accumulators are usually employed. We can previously determine the number of cells and the best method of grouping to give the necessary current with a portion of the extra resistance in circuit. The voltameter resistance will be about 25 ohms divided by the number of square cms. on one side of the cathode.

If the voltameter is for small and the galvanometer for large currents, the circuit is arranged as in the diagram.

R and *r* are straight German silver or platinoid wires or strip, eleven for example, having equal resistance, and connecting the heavy copper blocks, *b*, B and B′. One or more of the wires terminating in B may be shifted to *b* as required. Blocks, *b* and B, are connected by a sensitive zero galvanometer, *g*, some distance away to indicate whether or not they are at the same potential. If they are not, the potential of *b* is adjusted to that of B by means of the rheostat, *r*, next the voltameter, *v*. R′ is a heavy current resistance for adjusting the galvanometer, G (to be calibrated), to the required deflection. Accumulators, A, supply the current. With ten wires in B, and one in *r* and *b* and B at the same potential, the current through G will be ten times that passing through the voltameter.



If the voltameter is for large and the galvanometer for small currents, G and *v* in the diagram replace each other; or the "shunt" arrangement (shown in the January number of this journal, 1885) may be used.

The operation is sometimes begun with a trial deposit, lasting a few minutes. The cleaned plates are suspended in the solution, and the current adjusted to the proper strength by means of the extra resistance or subsequent change in the battery. The cathode is taken out—the circuit, exclusive of the voltameter, being kept closed in order that it may remain warm. If the small deposit is found to be firm and uniform on both sides, the plate has been properly cleaned and is in good condition to receive the regular deposit. It is then rinsed, dried and weighed as described, and replaced. If the plates are large, it may be necessary to put glass rods vertically between them to keep them from touching each other. The circuit is closed, and the time of closing noted. The needle is closely watched, and the current kept steady during the time of deposit which, as a rule, will be an hour or more. The time of opening the circuit is observed when the plates are taken out, the cathode washed and weighed as soon as it is thoroughly dried.

Large crystals on the edge indicate too great density of solution or current or both. If the deposit has a dark colour there was too little acid, and the gain of weight is too large.

It is easy to obtain a uniform and solid copper deposit, and if pains be taken to keep the bath acid, to clean the plates thoroughly before deposition, and after it to wash off the solution promptly and to dry the plates well before weighing, accordant results will be obtained.

THE BRITISH ASSOCIATION.

VORTEX ANALOGUE OF STATIC ELECTRICITY.

By Prof. W. M. Hicks, F.R.S.

(*Section A.—Mathematical and Physical Science.*)

Saturday, September 8th, 1888.

CONSIDER two bodies touching one another placed in an infinite fluid, and with a vortex filament, the ends of which are one on one surface, the other on the other. If now the surfaces be separated from one another, there will be formed at the point where they separate a hollow vortex filament stretching from one to the other, with rotation equal and opposite to that of the original filament. As the bodies are moved apart these filaments will not, in general, take up a position of rest. If the strength of the original filament be very great, or if there be several of them, the resulting hollow vortex will, through instability, split up into a number of smaller ones. If the resulting number be very large, they will ultimately take up some position of stable equilibrium. What the distribution in this will be I cannot say, but the following is one state of equilibrium, and, probably, although I have not proved it, a stable one. The two sets of filaments will be mixed up with one another, and each will distribute itself according to the same law as the distribution of lines of force between the two bodies supposed equally and oppositely electrified.

In the case of the original filament, as the surfaces are further and further separated, their sections become smaller and smaller. This is, however, not the case with the hollow filaments. Their sections depends only on the pressure of the fluid and their circulation, and as these remain constant, the areas of their section also remain so. In such a hollow vortex the pressure inside sinks to zero. Consequently the portion of the surface on which it abuts experiences a diminution of pressure, a diminution which is the same at all distances. The two bodies are therefore attracted towards one another. Moreover, as the two bodies separate further, the distribution of the filaments being the same as that of electrical lines of force, and the diminution of pressure for each line being constant, it follows that the force between the two bodies follows precisely the same laws as the force between the two bodies supposed equally and oppositely electrified.

If another surface be brought into the presence of the others, some of the filaments would abut on this. These would break off, rearrange themselves so that some of the filaments would end on it, and an equal number start from it. Call those ends of the filaments positive at which the rotation, looked at *from* the surface on which they abut, is right-handed; and those ends negative at which the rotation is left-handed. The two ends of any filament will then always be of opposite name.

The analogy with electrical action is then close. Two bodies, A, B, brought in contact touch in innumerable points. Owing, possibly, to the different states of motion of the ether at their surfaces, a state of equilibrium is set up, consisting of a kind of sifting of vortex motion already subsisting, so that, on the whole, more lines go from A to B than *vice versâ*. This is E.M.F. of contact. Separate the bodies, one has a number of positive ends of hollow filaments, and the other an equal number of negative ends. *The bodies are equally and oppositely electrified.* The force, in its hydro-dynamical case and in its electrical analogue, follow the same laws. Bring into the field another surface, C. The filaments rearrange themselves as mentioned above, the negative and positive ends abutting on C being equal. *This is induced electricity.* If the surface, C, consists of a large number of small unconnected surfaces, the filaments will arrange themselves in some manner depending on the sizes and distances of the unconnected parts, the field will be disturbed in a similar way to that in an electric field into which a dielectric is placed. This is the analogue of electric strain in a dielectric. So far, the ground is fully safe; the succeeding remarks must be regarded as speculation.

Returning to the case of the two separated surfaces, A and B, what will happen if they be connected by a third surface—say, to fix ideas, a long narrow cylinder or wire? It is not so easy to say certainly what the exact rearrangement will be. It would seem very probable that the hollow filaments near the wire would at once be replaced by circulation round the wire. In this case the solid filaments must rotate as a whole round it, while, at the same time, although this has not been proved, they will contract their ends more along until they come together, form a ring, and get mixed up in the surrounding fluid. This would correspond to the *current of discharge*. But notice that if this is so, the fluid outside the wire rotates round the wire, while a stationary state is being reached, and as we know that the field round a current is a magnetic field, it follows that the *analogue of a magnetic field is a flow along the magnetic lines of force*. It may, however, be further necessary that these streams must contain vortex filaments moving with the fluid, their axes at every point being perpendicular to the lines of force there.

If the field is determined by the flow of fluid independently of the vortex motion, it is not easy to see the hydro-dynamical analogue of the induction of currents, when, say, a wire moves across a uniform magnetic field. If, however, the vortex filaments, as above, are a necessary adjunct, it is conceivable how a movement of the wire across the lines of flow and amongst the filaments produce an instantaneous disarrangement, which will travel through the vortical fluid with the velocity of propagation of transverse vibrations in a vortical fluid. That is in the ether, as Sir W. Thomson has shown, with the velocity of light.

It is difficult to see any analogue to the rotation of the plane of polarisation of light by a magnetic field.

ON THE APPLICATION OF ELECTRICITY TO THE WORKING OF A 20-TON TRAVELLING CRANE.

By W. Anderson, M.I.C.E.

(*Section G.—Mechanical Science.—Monday, September 10th.*)

ONE of the travelling cranes in the foundry of the Erith Iron Works was originally constructed to be worked by hand, but preparations had been made for the application of wire-rope driving at some future time.

The crane is of 39 feet 6 inches span, and consists of a pair of wrought iron girders resting on end carriages, each running on two wheels on an elevated line of rails. The gearing for hoisting longitudinal and cross traverse is secured on to the tops of the main girders, the hoisting chain passes from the barrel, which is at one end of the crane, over a pulley at the other, then back to pulleys in the cross traversing carriage which runs between the main girders, thence through a falling block, and finally to an anchorage under the barrel at the extreme end of the main girders. By this arrangement the crane occupies a moderate height, and the hook can come within 3 feet of each wall.

The inconveniences and wear attending the use of rope-driving gear, or of a long main-driving shaft, and the dirt and special attention required by a steam crane, induced the writer to try whether electricity might not be used with advantage. Messrs. Elwell-Parker, of Wolverhampton, were communicated with, and these gentlemen undertook to supply the dynamo and a motor suitable for the peculiar requirements of a heavy crane. The dynamo, which is considerably larger than is needed for the crane in question, is arranged to give up to 80 ampères at 120 volts, with 1,200 revolutions per minute. The armature is of the cylinder type, field magnets shunt wound, resistance of armature ·07 ohm, and of the magnets 75 ohms. It is fixed in the main boiler house of the works, and is driven by a horizontal engine having a cylinder 9½ inches diameter, 12 inches stroke, running at 180 revolutions, with 50 lbs. steam, by means of a link belt. The leads from the boiler house up to the conductor in the foundry for a distance of 60 feet are of No. 6 B.W.G. copper wire, while the conductor in the foundry is formed of an angle-iron bar, 2 inches by 2 inches by ½ inch, extending the whole 350 feet length of the shop; it has one face roughly ground, and protected from rust by vaseline, and is secured to the iron pillar supporting the roof, being insulated by wood blocks. The return current travels along one of the rails on which the crane runs, the joints of the rails being united electrically by copper staples. The motor is one of Messrs. Elwell-Parker's latest types with single vertical magnet and a drum armature. It is shunt wound, and constructed for 100 volts and 50 ampères; the armature resistance is ·056 ohm, that of the shunt 49·2 ohms. It is fixed on the working platform of the crane beside one of the main girders; its driving spindle carries a steel pinion, which gears into a double helical spur wheel, keyed on to a shaft which runs longitudinally on the top of the girder, and is connected by nests of three bevel wheels, with friction clutch connections, to the three shafts which command the several movements of the crane, the means of using the hand-power being still retained. Two sets of speed are arranged for each of the movements, mamely:

Hoisting slow, 3·4 feet per min., fast 10 feet per min.
Cross traverse, 25 feet „ „ 105 „
Longitudinal traverse slow, 78 feet, fast 213 feet per min.

To provide against an undue current passing through the motor, an automatic magnetic cut-out is fixed on the crane, and, as an additional security, a fusible wire is placed close to the dynamo to provide for the contingency of a short circuit. For the purpose of varying the power and speed to meet the requirements of the foundry a set of resistance coils is provided, governed by a special switch, by means of which different resistances can be introduced into the armature circuit of the motor, and the current can be cut off altogether, but so that it must be done by steps, and not suddenly. In starting the motor, the reverse action takes place. The shunt coils of the magnets are connected to the two collectors, so that the fields are always excited when the dynamo is running, whether the motor is working or not, the switch controlling only the armature circuit. The collector for the angle iron conductor consists of a pair of insulated brass blocks pressed against it by means of a flat spring, having a considerable range. An ordinary wire brush serves to collect the current from the rail, but the axle of one of the wheels is also connected to this brush to provide for the contact being in any way interrupted.

The handles for operating the several movements, the brake lever, the switch and the automatic cut-out are all collected together, so that a single attendant can readily work the crane from one spot.

The crane was set to work in June last, and has continued to act satisfactorily ever since. The advantages of working by electricity are very great, especially in comparison with steam cranes. In large works a powerful dynamo would be established and be driven by engines of an economical type. The steam from the main boilers is necessarily always available when the factory is at work, and the current can be easily carried into any part of the establishment. Steam cranes require the attendant to be at his post an hour or more before the works open, water and fuel have to be hoisted on to the crane, and the working is accompanied by dirt, steam, and smoke, the latter especially objectionable with overhead lights or in shops where bright work is prepared or erected.

The duty realised is about 65 per cent. of the power developed in the driving steam engine. As far as can be judged at present, there is no special wear to apprehend, the conductors act satisfactorily, though a considerable length is in the open air, and the dust, heat, and smoke of the foundry do not appear to affect the working.

TABLE A.—EXPERIMENTS ON ELECTRIC FOUNDRY CRANE.—*Erith Iron Works, August*, 1888.

—	Load on hook.	Total load on rails.	Volts at dynamo.	Ampères in circuit.	Watts at dynamo.	Watts at crane (mean).	Horse-power at crane (mean).	Speed of motor, revs. per minute.	Speed of crane movement, ft. per min.
Cross traverse, quick gear	...	18 tons 0 cwt.	120	27	3,240	3,202	3·78	1,166	105·
Long traverse, „ „	...	„ „	105	48	5,040	4,925	5·81	1,100	201·3
Hoisting, „ „	...	„ „	110	22	2,420	2,398	2·85	1,166	9·92
Cross traverse, „ „	4 tons 12 cwt.	22 tons 12 cwt.	98	47	4,606	4,493	5·3	1,100	99
Long traverse, „ „	„ „	„ „	86	80	6,880	6,560	7·74	1,050	192
Hoisting, „ „	„ „	„ „	90	76	6,840	6,551	7·73	1,050	8·92
Cross traverse, „ „	9 tons 11¾ cwt.	27 tons 11¾ cwt.	130	65	8,450	8,229	9·71	1,166	105
Long traverse, „ „	„ „	„ „	115	78	8,970	8,666	10·23	1,166	213
Hoisting, slow gear	„ „	„ „	103	58	5,974	5,806	6·85	1,117	3·27
Cross traverse, „ „	14 tons 2¾ cwt.	32 tons 2¾ cwt.	112	44	4,928	4,831	5·7	1,166	25·3
Long traverse, „ „	„ „	„ „	135	38	5,130	5,058	5·97	1,333	89·3
Hoisting, „ „	„ „	„ „	115	73	8,395	8,125	9·59	1,133	3·317
Cross traverse, „ „	19 tons 2¾ cwt.	37 tons 2¾ cwt.	135	51	6,885	6,752	7·97	1,266	27·5
Long traverse, „ „	„ „	„ „	130	46	5,980	5,874	6 93	1.250	83·7
Hoisting, „ „	„ „	„ „	98	86	8,428	8,058	9·95	1,016	2·976

The table gives the electrical measurements made by Mr. E. W. Anderson, to whom the author is indebted for carrying out this comparatively novel application of electricity.

When first proposed, the writer was not aware of the existence of any other electric crane, but he has since learned that Messrs. Mather and Platt, of Manchester, have had one working satisfactorily for some time, and that there is one also in France.

DISCUSSION.

Mr. SYDNEY WALKER asked if there was any special reason for employing a shunt-wound motor. He observed that both dynamo and motor were shunt-wound in this case. He understood that series-wound had been used previously, but that no special advantage was found. So far as he could gather from studying the subject, a compound-wound motor would answer in most cases where the load was variable.

Mr. STOTHERT asked if there was any advantage in having three motors instead of one, seeing that the work was variable.

MAJOR-GENERAL WEBBER and Mr. KILLINGWORTH HEDGES having put questions which were imperfectly heard,

Sir FREDERICK BRAMWELL, alluding to one of the diagrams, said, assuming the motor to be raising a weight, if some connection were to break, what was to prevent the whole thing from going backwards? That was to say, was the connection between the motor and the crane in some part where it could not be overhauled? He presumed it was, otherwise it seemed to him mischief might occur. Obviously the mischief could be easily remedied by placing a weight so that it could not be overhauled. He understood Mr. Anderson to say that 65 per cent. could be obtained out of the traveller as compared with the horse-power developed by the steam engine. He (Sir Frederick) would be glad if he could give them any information as to the percentage developed by the slow-rope traveller, and also the percentage obtained when the steam engine is on the traveller itself. He was sure that all who had had to do with these things practically would agree with Mr. Anderson that any means of getting rid of the steam engine from the platform was most desirable.

Mr. ANDERSON, in reply, said, with reference to the first question as to why a particular form of motor and dynamo was used, he was not sufficiently versed in the mysteries of dynamos and motors to be able to give a reason. He had simply adopted the form recommended by Messrs. Elwell-Parker. With regard to Mr. Stothert's question, he thought it might possibly be better with a very large crane to employ three motors; but this was a comparatively small crane, and one motor answered very well. The connection between the shafts was by friction clutches. They very soon found out that a certain amount of knack was required by the attendant to throw the shafting motor in and out of gear, so as not to put an undue strain on the motor at once. They had to put it in gently, though the time difference was not perceptible. With regard to the lowering arrangement, the brake was of peculiar construction, and one which he had adopted for a very long time. Inside the brake was a ratchet with four differential pawls. The ratchet worked inside the brake. Supposing the weight overpowered the dynamo, the ratchet fell in and the brake held the load. For simply lowering, they released the lever, and there was no strain in and out of the ratchet at all. The ratchet was always ready to go into gear, and the brake was always ready to lower. The only trouble they had had was due to the fact that the makers miscalculated the resistance of the coils; there was not nearly enough resistance. But by extending the wire they overcame the difficulty, and the crane worked very well, and without the least trouble so far. He had no information about the percentage of work delivered by either the quick or slow rate of working, and he did not very well see how they were to get a fair statement of the percentage with a duplicate crane of that kind, for the reason that the time of running was so very short. If they took the total work for 10 hours, saw how much the crane lifted in that time, and then found what duty they got, that would be a fair way of looking at it. He thought Sir Frederick Bramwell's suggestion of making the contact on the underside was a very good one, and he should not forget it when building another crane. The cost was about £300.

The PRESIDENT said it was his duty to propose that the thanks of the section be given to Mr. Anderson for his extremely interesting paper. There was one very serious omission in the paper, which he (the President) thought it was his duty to supply. When mentioning that he had been assisted in working out the details and making the experiments by Mr. E. W. Anderson, Mr. Anderson forgot to mention that Mr. E. W. Anderson was his own son. It was to be hoped that the son would follow in the footsteps of his father.

The Proposed Pacific Cable.—According to a Reuter's telegram from Ottawa, Mr. Sandford Fleming has made public there some information recently received from Australia by the Pacific coast mail respecting the proposed Pacific cable. According to this intelligence the Governments and people of the different Australian colonies warmly support the idea of a cable between Australia and Canada, and the Premier of Victoria is making special efforts to secure the joint action of all the Australian Governments to urge the subject in the strongest terms upon the attention of the Imperial Government.

NOTES.

Electric Light at Oporto.—Messrs. Silva and Cosens, the largest shippers of port wine from Portugal, last winter lit their extensive stores with electric light. The order for the machinery was placed with Messrs. Walter T. Glover & Co., 10, Hatton Garden, Holborn, E.C., and consists of a 16-arc light dynamo on the Hochhausen system with patent regulator attached. There are 12 double carbon arc lamps by the same maker said to be 2,000 candle-power each, besides 20 to 25 "Bernstein" incandescent lamps of 20 C.P. for the engine rooms, boiler house, passages, &c., and also a parallel of 11 Swan incandescents for the general offices. There are, therefore, three distinct systems worked on the same circuit with a current of 10 ampères. The dynamo gives about 800 volts, and is driven by an "Armington-Sims" engine constructed by Messrs. Greenwood and Batley, of Leeds. The arc lamps are beautifully steady, and the incandescents leave nothing to be desired. One notable feature about the installation is that the circuit is divided into three divisions, viz., the "middle," "east" and "west," representing respectively the steam and hand cooperages, the new stores and the old stores. It is often necessary that one of these divisions should work overtime and not the others. So beautifully does the "Hochhausen" regulator work, and so wonderfully has the "Armington" cut-off got the engine under control, that at any moment either one or two of these divisions may be switched out, representing half the entire load, without going near the engine or dynamo, which immediately adjust themselves to the altered conditions—a real blessing to the man in charge, and the secret of the good working of the entire system. The whole of the plant was ordered by and erected under the supervision of Mr. Wm. Pole Routh (M.I.M.E.), the consulting engineer to Messrs. Silva and Cosens, and in practice it is most satisfactory and very cheaply worked.

St. James's and the Electric Light.—At a meeting of the St. James's Vestry last week, the Lighting Committee reported with regard to the application from the Metropolitan Electric Supply Company, that it could not see that the Vestry was prepared to assent to a licence in the form submitted; and recommended "that the London Electric Supply Corporation be informed that the Vestry has already consented to the establishment of two electric lighting instalments in this parish, and that it is not prepared to assent to any further licence or provisional order until the instalments are either fully at work, or have been abandoned." Mr. William Jenkins moved the adoption of the recommendations, and Mr. Burgess pointed out that if consent were given to any number of these companies, the roads and footways in the parish would be continually being torn up to lay the necessary electric cables. The motion was adopted.

Fulham and the Electric Light.—The Law and Parliamentary Committee of the Fulham Vestry has recommended that the solicitor to the Vestry be instructed to oppose the proposed bills to supply the parish with electricity. This recommendation has been accepted by the Vestry.

Public Electric Lighting in Liverpool.—Since the license from the Board of Trade was obtained by the Liverpool Electric Supply Company for special powers to fix wires underground for lighting the streets and public buildings with electricity, *Industries* states, the company has been negotiating with the Corporation officials about the best positions for laying the wires. The impervious pavement, which is universally adopted in Liverpool, has given rise to many difficulties, for when once laid it cannot be broken into without at once annulling its principal advantage. A satisfactory arrangement has, however, at last been made, and the cables are now being laid from the central station in Tithebarn Street.

Metropolitan Electric Supply Company.—The Metropolitan Electric Supply Company is about to erect new offices at the central supply station. The company has just purchased a site for the purpose on the Surrey side of Waterloo Bridge, immediately adjoining the large steam flour mills on the south bank of the Thames. The new buildings are to be commenced immediately.

Westminster and the Electric Light.—At a meeting of the St. Margaret's and St. John's Vestry, Westminster, last week, the Parliamentary Committee submitted a report dealing with the lighting of the district by electricity. It recommended that the applications for licences by the London Electric Supply Corporation and the Metropolitan Electric Supply Company be objected to on the grounds that the Vestry should retain the control of the lighting of the parish in its own hands; and, in view of the importance of the subject, asked the Vestry for an expression of opinion as to applying for a licence empowering the Vestry to undertake the lighting of the parish. Mr. Thomas Horn moved the adoption of this, and, as a practical man, said that the electric lighting of districts up to the present time had been an utter failure. Mr. Henry Verity said that the opposing of such a grand improvement as this would lay them open to the charge that they were interested in the gas company. After a long discussion, the Vestry adopted the report and recommendation by a large majority. The committee, however, was requested to prepare a report as to the suggestion of the Vestry itself taking the necessary steps to supply electrical power for lighting.

Electric Lighting in South Wales.—The Albion Steam Coal Company has decided to light up its new colliery near Pontypridd by means of the electric light. The installation, which is to be of a very complete character, has been placed in the hands of the Gülcher Electric Light and Power Company, Limited, who, it will be remembered, also lighted the Ynishir Steam Coal Company some two years ago, with highly satisfactory results. The installation for the Albion Company will consist of a horizontal engine, with automatic gear, driving a Gülcher self-regulating dynamo, which will supply current to 114 16-C.P. incandescent lamps, 54 of the lamps being underground; in all cases exceptionally strong fittings will be used in order to withstand the rough wear and tear of colliery work. The company has decided to use lead covered cable for conveying the current down the shaft.

The Electric Light in Paris.—The Paris Municipal Council has adjourned the consideration of two demands for concessions for the installation of the electric light, the two companies making the requests being the Company for the Transmission of Power by Electricity (Deprez system), and the Continental Edison Company. The Deprez Company offered to distribute the light and motive power in the district comprised between the Rue du Caire, the Place de la République, the Boulevard Magenta, and the Faubourgs St. Martin and St. Denis. This demand was not conformable to the decision of the Council, according to which the concessions must have reference to the sectors extending from the centre of Paris to the fortifications, so that it stands a good chance of being refused if this portion of it be not modified between now and its reconsideration. The Edison Company wishes, on the contrary, to light the Bourse quarter and the line of boulevards between the Opera and the Porte St. Martin, the Faubourg Montmartre, and the Rue des Martyrs, as well as the exterior boulevards between the Collège Rollin and the Place Clichy.

Private House Lighting.—The new residence, recently built by Mr. Courtauld at Braintree, is fitted throughout with the electric light. The power is obtained from a Marshall engine, which drives an Elwell-Parker dynamo to charge 52 cells. The work has been carried out by Messrs. Drake and Gorham.

Lighting of the Madrid Opera House.—This installation is by far the most important in Spain. There are three Babcock and Wilcox boilers of 80 H.P. The engines and dynamos come from the Oerlikon works; there are four of the former, each of 60 H.P., coupled direct to the dynamos. The interior of the building is to be fitted with 2,800 Swan incandescence lamps, while for the outside illumination there will be five or six arc lamps. The work has been carried out by the Matriteuse Company.

Electric Lighting at Glasgow.—We learn that Mr. Wm. A. Bryson, the well-known electrical engineer, has arranged, for the directors of the Scottish Panorama Company, with Mr. Richard Millar, Glasgow, to instal 11 Thomson-Houston arc lamps and 60 incandescent, of 16 C.P. each. Eight arc lamps will be placed round the picture of Bannockburn, and the remainder outside, whilst the incandescent lamps will be used in the restaurant and passages. The plant will consist of one 10-H.P. Robey compound horizontal engine, and one 16-H.P. Robey locomotive boiler (the extra power being used for heating purposes), one 12-light Thomson-Houston dynamo, and one incandescent dynamo, Thomson-Houston type.

Electric Lighting at Bath.—Much satisfaction, says the *Bath Herald*, appears to be expressed with the effect of the electric light so far as it has been introduced in several business establishments in the centre of the city. Both arc and incandescent lamps are employed, the former for outdoor and indoor illumination, and the latter for indoor lighting only. Mr. Massingham and Mr. Stoffell, at the entrance to the Corridor, have each five arc lamps; but lower down, Messrs. Lloyd and Co.'s establishment is lighted throughout with incandescent lamps. Messrs. Noble and Chivers, New Bond Street Buildings, have an arc lamp outside and an incandescent lamp to light a side window, and also two similar lamps inside the shop. Mr. Alfred Taylor, New Bond Street, displays an arc lamp outside his shop, and has an incandescent lamp in an inner office. All those who are using the electric light inside as well as out are using no gas at all in their business premises. Arc lamps are also placed outside the shop of Mr. Pinch, Cheap Street, the Full Moon, Upper Borough Walls, and the Christopher Hotel. Mr. Massingham has also, at his own expense, placed five incandescent lamps in the reading room at the Athenæum for a month, and we understand that the substitution of the light for gas has been very greatly appreciated. These incandescent lamps are all of 32 candle-power, while the arc lamps are of 1,200 candle-power, but are covered with opaque globes in order to somewhat subdue the light for shop purposes. Different globes would be used for street lighting.

Mansion Lighting.—Mr. C. P. Huntington, J.P., of Astley Bank, Lancashire, who has for several years had his residence lighted by electricity, has now extended his installation and introduced the storage element. The machinery and apparatus are placed in buildings separate from the house, the current being produced by means of a "Victoria" shunt-wound dynamo, giving 50 ampères and 75 volts. The machine, which can be used either for charging the accumulators or working the lamps, is driven at a speed of 650 revolutions per minute by an "Otto" gas engine of 3½ H.P. nominal. In the room next to the dynamo house are placed the accumulators (32 in number). They are all of the latest type, and when fully charged are capable of supplying current for 60 17-C.P. lamps for a period of 10 hours. The work has been carried out by Mr. Thos. Barton, electrical engineer, of Blackburn, who has already erected several successful installations in Darwen and district, notably those of Messrs. C. and J. G. Potter, Belgrave Mills, 130 lights, and Hollins Mills, 350 lights; Darwen Paper Mill Company, Spring Vale, 300 lights, and Lower Darwen Mills, 100 lights; Star Paper Mill Company, Feniscowles, 350 lights; Messrs. J. Place and Sons, Hoddlesden, 4 arc lamps, each of 2,000 C.P.

United Telephone Company.—The adverse criticisms which have been passed upon the methods of the United Telephone Company, says *Truth*, have apparently taken effect, for I hear that, with a view to a reorganisation of the London system, all the principal officials have received notice, although this does not necessarily imply, I am told, that they will all be dismissed, the step being taken in order to facilitate a rearrangement. It seems to me, however, that it would have been better to begin by cutting off the head instead of the tail. I am also informed that there is no chance of the proposed amalgamation of the various telephone companies coming about as long as Mr. Morgan, on behalf of the United Telephone Company, puts an impossible value upon the company's wretched London system, and upon the business of two of the smaller subsidiary companies, the Western Counties and the Northern District, which are as yet quite undeveloped.

The Telephone in Kent.—The South of England Telephone Company has just completed a trunk line connecting Dover and Folkestone with Canterbury, and is proceeding with the erection of trunk lines between Canterbury and Ramsgate, and Northampton and Kettering. The lines recently erected connecting Brighton with Shoreham, Worthing, Lewes and Eastbourne are working satisfactorily.

Cable Communication with Australasia.—The Eastern Extension, Australasia and China Telegraph Company notified at the beginning of the week that telegraphic communication had been restored with Australia and New Zealand.

Interruptions and Repairs to Submarine Cables and Land Lines:—

	Interrupted.		Repaired.
Cuba land lines	7th Aug.,	1888.	Still interrupted
Mexican land lines between Yucatan, Oaxaca, Chiapas and Tabasco	17th Sept.,	„	Still interrupted
Saigon-Bangkok land line ...	12th Aug.,	„	5th Sept., 1888.
Cables.—Accra-Lagos	25th July,	„	8th „ „
„ Aden-Bombay	11th Aug.,	„	11th „ „
„ Javer-Ibiza (Balearic Islands)	11th Feb.,	„	20th „ „
„ Brest-St. Pierre ...	24th Sept.,	„	Still interrupted
„ Para-Maranham ...	6th „	„	24th Sept., 1888.
„ Accra-Sierra Leone	10th Oct.,	„	Still interrupted
„ Banjowangie - Port Darwin (both) ...	9th „	„	*14th Oct., 1888.
„ Bushire-Jask	13th Aug.,	„	1st Sept. „

* Not stated whether both cables are repaired, or only one.

A New Cable Enterprise for Cuba.—The *Gaceta de Madrid* of the 20th August last contains a Royal decree granting to Don Augusto Ghirlanda y Hernandez a concession for the laying and working of a submarine cable between the Island of Cuba and the peninsula of Yucatan (Mexico).

Concession for Submarine Cables.—The Governments of the Dutch colonies of Surinam and Curaçao granted to the Pedro Segundo Telegraph and Cable Company early this year a concession for laying submarine telegraph cables between Willemstad (Curaçao), Paramarito (Surinam), and Vizen (Brazil). These cables must be laid and in working order within 18 months from the date of the concession, which has been given for a term of 60 years. An annual subsidy of 20,000 florins will be paid the company for a period of 20 years, commencing on the day the cables, being sound and perfect, are placed in efficient working order. The concession rigourously forbids the sending of any telegrams originating in Curaçao to Europe or North America, *via* Brazil, unless the Antilles Cable Company's lines, *via* Hayti and Santiago de Cuba, should be interrupted. The concession will be annulled should this clause be infringed. It is the intention of the Pedro Segundo Company to connect Paramarito with the French colony of Cayenne (French Guiana) so soon as the necessary concession has been obtained from the French Government.

The Submarine Cable Convention.—According to a *Times* Paris telegram, the English Government has notified the adhesion to the Submarine Cable Convention of Canada, Newfoundland, the Cape, Natal, New South Wales, Tasmania, Western Australia, and New Zealand.

Interception of Messages.—M. H. Discher, controller in the Austrian postal service, in a communication to the Berne *Journal Télégraphique*, suggests a method for preventing the interception of messages in wartime. He remarks that whereas it was formerly necessary to cut the line, the invention of the telephone now renders it possible to read every Morse signal passing along the line from a considerable distance by erecting a parallel line of short length with a telephone in circuit. He recommends the employment of the duplex system, one station sending the proper telegrams while the other transmits some text determined on beforehand. The signals then received by any instrument interposed on the line, or by a telephone on a neighbouring and parallel line, will be so confused as to be unintelligible. He refers more especially to the employment of the Morse instrument, as this is the one most generally used in field operations.

Telegraph Maps.—The *Berne International* office has lately published a new edition of the telegraph lines comprised in the extra-European *régime*, in four sheets. A fresh general chart of the telegraphic communications of the world has also appeared in one large sheet, showing the modifications which have occurred since last November.

Telegraph Communication with Australia.—According to newspaper accounts there seems to exist a considerable discrepancy between the views adopted by Mr. Sandford Fleming and those entertained by Sir John Pender, as to the feelings of our Australian Colonies upon the question of the monopoly held at present by the Eastern Extension, Australasia, and China Telegraph Company, and as to the feasibility of a competing line from Vancouver across the Pacific. The recent interruptions of telegraphic communication between Banjoewangie and Port Darwin will certainly act as a stimulus to the advocates of the rival scheme. Sir John Pender's argument against a Pacific line seems to be that if two cables break down, a third will only add to the increase of interruptions.

Telephonic Extension in Hampshire.—The Western Counties and South Wales Telephone Company has completed its arrangements for the erection of a trunk line running between Portsmouth, Gosport, Fareham, Winchester, Southampton and Bournemouth. Permission has now been obtained from the various local authorities for the carrying of wires over all the main roads between those towns. The centre of the system will be Southampton, whence lines will radiate east to Portsmouth, west to Bournemouth, and north to Winchester.

Electric Train Lighting.—What has happened on the Glasgow Underground Railway? We were under the impression—an impression shared by the Lord Provost of Glasgow—that the lighting of the carriages on that line was effected by electricity, an automatic arrangement causing the incandescent lamps to shine forth when the trains entered the tunnels, and stopping the supply of current as soon as the tunnels were passed. But it seems either this arrangement was merely a temporary one, or is only used to a very limited extent, for a facetious writer in the Glasgow *Evening Times*, commenting upon the Lord Provost's statement of the manner in which the trains were lighted, says:—"Indeed! Has the Lord Provost ever seen this beautiful automaton at work? In every underground train I have ever travelled by the light has been extinguished as soon as the train entered the tunnnel by the automatic process of the non-transparent roof of the tunnel cutting off the rays of the sun."

The Institute of Medical Electricity.—The inaugural *conversazione* of the Institute of Medical Electricity takes place on Tuesday, the 30th inst. Early in the evening a short address, illustrated by experiments, will be delivered by Prof. Silvanus P. Thompson. We trust that this meeting may be the means of making the institute better known, both to the electrical fraternity and to the general public.

Correction.—In the third line of Mr. Desmond FitzGerald's communication on "What is Electricity" last week, the expression $Q = \frac{E}{2R'}$ should have been $Q = \frac{E}{R'}$.

Electrical Distribution.—With reference to our note on p. 287 of September 14th, on the similarity of an American specification to that of Mr. H. Edmunds, we are requested to say that American patents have been granted to the latter both for his system and methods of working without any demur. This he thinks disposes of the idea that the patent to which we referred has any bearing on his own.

Electro-Harmonic Society.—Next Friday the very enjoyable musical evenings of the Electro-Harmonic Society will be resumed, and the programme, which can be found in our other columns, shows that the opening concert will bear comparison with any which have gone before. With such an accomplished quartette of vocalists, and with instrumentalists of the calibre of Messrs. Albert and Izard, lovers of sweet sounds will find enough to satisfy all tastes. Sir William Thomson has very kindly promised to preside at one of the meetings of the Society during the forthcoming session if the dates are found to come within the period of any of his visits to London. We fervently hope that Sir William may be able to time his sojourn in town so as to include one of the six evenings, and we feel sure our wish will be re-echoed by every member of the society.

Obituary.—We regret to learn that M. Cabanellas died a few days since at the age of 49. He was formerly a naval officer, but after the last Franco-German war he devoted himself specially to the problems connected with the electrical transmission of power, and during the time of Marcel Deprez's experiments his name frequently figured in our columns. He was an officer of the Legion of Honour.

Electricity for the Underground.—One day last week the directors of the Metropolitan Railway Company met to consider the question of employing electricity in lieu of steam as a locomotive agent. The experiments have been going forward for a considerable time, and it is said that the Electric Company has been so sanguine of success that it has already spent £10,000 in carrying forward the experiments on the sections of the lines open to them by the Metropolitan Railway, but no definite proposals or specifications have yet been submitted. The case has now reached a point at which the directors of the Metropolitan Railway Company admit that it may be seriously considered from the point of view of expense and practicability. Early in the new year a decision will be taken one way or the other.

Electric Search Lights.—A new pattern of portable electric search light is now being fitted to the *Hecla*, torpedo depôt-ship. The novelty consists in a Siemens dynamo and projector, mounted on the same carriages as a Merryweather's engine and boiler of the description so long and successfully used for fire purposes. The carriage can be drawn either by man or beast, and it is easy to see how invaluable such an arrangement might be during night skirmishing in a rough country—say, Suakin or the Black Mountain. At present, at the former place we are depending on the good offices of a telegraph company's repairing ship for any electric light at all.

Safety Lamps.—At a meeting of the members of the North of England Mining Institute, at Newcastle last Saturday, Mr. Oswald Swete exhibited an electric safety miner's lamp, made by the New Portable Electric Lamp and Power Syndicate Company. He briefly explained the construction of the lamp, in which improvements had been made since it was shown to the members of the Institute early this year. The weight of the lamp is 4½ lbs., its first cost about £1, and the cost of maintenance 3d. per week of six days per week, and running 12 hours per day; the 3d. includes the cost of repairs, interest on plant, depreciation of machinery, and renewals of incandescent lamps when necessary. A one-unit dynamo will charge 130 lamps. The light is protected by toughened glass, and if the glass should be broken a lever falls forward and puts out the light. The lamp has not any apparatus for detecting the presence of gas; but Mr. Swete stated that he hoped to succeed in getting such an apparatus. Mr. Swete has also exhibited the lamp at various other places in the North.

At a meeting of the Mining Institute of Scotland, at Glasgow this week, Mr. Dalgleish exhibited and described the Edison and Swan Company's electric safety lamp. It gave a light of about one candle-power for a period of about 10 to 15 hours, and consists of a storage battery of four cells enclosed in a strong teak box turned out of the solid and strengthened with metal bands, and a small burner mounted on the side of the case, and protected by a strong glass cover. The case is fitted with a hinged lid, secured by a crossbar fastened with a safety nut, and having a swivel handle. The full size of the lamp was 7 inches by 4½ inches, and the weight of the whole ready for use about 7 lbs. It was intended to be fitted with a fire-damp indicator.

Compound Winding.—The trial of the action in the Scottish Courts between the Anglo-American Brush Electric Light Corporation and Messrs. King, Brown and Co., with reference to compound winding patents, is fixed for November 27th.

The Copper Syndicate.—The *Financial News* learns that M. Secretan is expected in London shortly for the purpose of taking the necessary steps to turn his Copper Syndicate into an English company under the Limited Liability Acts. It is given out that Messrs. Barings are behind the enterprise, and the support of the Rio Tinto group and the members of the existing syndicate is assured. The title of the new company has not been decided upon, but it will probably not include the word copper in any form. It will have for its objects the cornering of products generally, as opportunities may arise. It will be, in fact, a sort of International Cornering Syndicate.

The Life of Glow Lamps.—Occasionally we have information sent to us relating to long-lived incandescent lamps, and recently we noticed the case of an Edison lamp which had been over 7,000 hours in use. Of course this may mean something or nothing, according to whether we know the electrical constants of the lamp or not. Still such items of news are interesting, and the experiences of Mr. A. Sopwith at the Cannock Chase Colliery are worthy of being placed on record. When the installation was first started, Mr. Sopwith states that the efficiency of the Woodhouse and Rawson lamps was very marked, and he finds the following lives recorded out of 200 lamps:—7,475, 6,897, 6,379, 5,957, 5,002, 4,939, 4,176, 3,955, 3,686, 3,575 hours. The average life, including breakages, was about 2,000 hours. It is true, says Mr. Sopwith, that in the absence of continuous observations as to the voltage to which the lamps were subjected, the above-mentioned lives have not a definite meaning, but they represent the lives of the lamps under actual requirements. There are other lamps still burning which he thinks must have a record as good or even better than those enumerated, and he gives a most unqualified opinion as to the high efficiency of Woodhouse and Rawson's lamps.

South of England Telephone Company, Limited.—The directors have elected Mr. Charles Billett, of Copthall Buildings, E.C., to a seat at the board in place of Mr. T. F. Campbell, deceased.

Electricity in the Blacksmith's Shop.—Writing to the *Scientific American*, Mr. J. C. Henry suggests a novel means of testing the condition of horses' feet. He says:—Take a battery or magneto machine, one that gives a light current, say such as can only be felt with moist hands. Attach one terminal to the animal's bit, the other to the shoe. If the horse suffers from the shoe or nails, he will squirm under the test. If there is no irritation, it will pay no attention to it. A little electrical science in blacksmiths' shops would locate much suffering.

Electric Fishes.—While I was fishing for cod the other day off Walmer, writes W. H. Copfield in *Nature*, I took up in my hand a small whiting pout that was flopping about in the bottom of the boat, when I received what appeared to me a slight though distinct electric shock in the palm of my hand, which made me exclaim at once, "That fish has given me an electric shock." On asking the fisherman (70 years of age) if he had known of such a thing occurring before, he said that he had "heard tell of it," and on enquiring further I found that he was referring to whiting pout and not to any other fish. He had never, however, noticed anything of the kind himself. It will be interesting to know if any of your correspondents can confirm the observation.

Reducing the Price of Gas.—The partial introduction of electricity into Hastings has already had an admirable practical effect. At a recent meeting of the Corporation a communication was read from the Gas Company to the effect that on January 1st next the price of lighting the ordinary public lamps would again be reduced by 3s. per lamp per annum, and the Whitehall lamp by 7s. 10d. The annual charge for an ordinary lamp will then be £4 4s. 3d., and for a Whitehall lamp £10 13s. 8d. Further reductions would also be made in the cost of lighting the High Street clock and the two lighthouses. It was stated by a member of the council that private consumers' bills were just as heavy as before the last concession.

Electric Trams.—Says *Truth*:—"My comments upon the sad plight in which the tramway and omnibus companies find themselves in view of the high price of fodder, and my question why our electricians could not give us electric traction, which is already so largely introduced in the United States, have brought me several letters from electric engineers and others interested in this question. I hear that the chairman of the Birmingham Central Tramway, who has obtained the control of the Julien patents, which are being worked on the Brussels tramway, is sanguine of being able to successfully introduce this system in this country, although certain improvements will first have to be made. Mr. Thomas Frazer, the engineer of the Electric Traction Company, writes that he is building half a dozen electrical tramcars for the equipment of the North Metropolitan Tramway Company's Canning Town line, one of which is already completed. I have also received a communication from the Series Electrical Traction Syndicate, Limited, of 11, Queen Victoria Street, according to which the construction of a line near London on their system (to which Prof. Ayrton called attention at the recent meeting of the British Association) has already been commenced. This line will probably be opened for traffic in the early part of December. Messrs. Woodhouse and Rawson, the well-known electrical engineers, also inform me that they are prepared to take contracts for running tramcars by electricity at a considerably less price than by horses. It is to be hoped that the tramway directors will be enterprising enough to avail themselves of this means of considerably affecting their companies' dividends, and, in fact, of giving many of them a fresh lease of life."

An Electric Shell.—Experiments are being carried out at Kiel on an electric shell and with Zalinski's pneumatic gun. The shell is about 6 feet 8 inches long, weighs about 220 lbs., and carries a charge of 600 lbs. of blasting gelatine. The shell is exploded either by impact or by an electric current. In the latter case it is necessary that the projectile should fall into water which is admitted to a chloride of silver battery contained in the shell, the current thus produced taking effect on the charge in two seconds after the missile has struck the water.

Sir John Pender.—On Tuesday Sir John Pender was presented with the freedom of the Burgh of Dingwall in recognition of his eminent services to the county in connection with the extension of submarine telegraphy throughout the world. Provost Ross presided, and there was a large attendance. In presenting the freedom of the burgh to Sir John, Provost Ross alluded to the distinguished position which he occupied in the work of submarine telegraphy all over the world. During his Parliamentary career Sir John Pender had always evinced a deep interest in the welfare of the northern burghs, and the freedom of the burgh was now conferred upon him, not only on account of his being a prominent and distinguished man, but also as a mark of the people's gratitude for many acts of kindness. Sir John Pender, in acknowledging the honour conferred upon him, sketched the great progress made in submarine telegraphy, and said it had become a universal promoter of peace and harmony, and it had brought nations more closely together. Sir George Elliot also spoke. At the close Sir John was entertained at a banquet.

The Deptford Central Station.—We understand that on Wednesday next the directors of the London Electric Supply Corporation, Limited, have arranged to give a Press view of the Deptford Central Station. Probably the publicity given will be the means of enlisting still greater sympathy with the efforts which are now being so strenuously made to introduce the electric light from central stations.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Automatic Electrical Corporation, Limited.—The statutory return of this company, made up to the 4th inst., was filed on the 10th. The nominal capital is £75,000, in 3,750 shares of £20 each. The only shares at present taken up are the seven subscribed for at the registration of the company, and upon these no call has been made. Registered office, Winchester House, Old Broad Street.

Automatic Electric Railway Signal Company, Limited. — At an extraordinary meeting of this company, held at the Sale Rooms, Tithebarn Street, Liverpool, on the 18th ult., a special resolution was passed authorising the sale of the company's patent rights, signals, stock-in-trade, contracts, business, and goodwill to Mr. Walter Walker, or his nominees, for £74,500, of which £73,200 is payable in fully paid shares of a company to be formed with a capital of not less than £200,000, the balance of £1,300 is to be paid in cash. The resolution was confirmed on the 5th inst., and duly filed on the 10th inst.

Telephone Union, Limited.—The registered office of this company is now situate at 1, 2 and 3, Oxford Court, Cannon Street.

United Kingdom Telephone Union, Limited.—The registered office of this company is now situate at 1, 2 and 3, Oxford Court, Cannon Street.

City of Westminster Electrical Syndicate, Limited.—The statutory return of this company, made up to the 15th inst., was filed on the same day. The nominal capital is £10,000 in £1 shares. 1,500 shares have been taken up, and the full amount has been paid thereon. Registered office, 6, Westminster Chambers, Victoria Street.

Ward Electrical Car Company, Limited.—An agreement of 1st inst. provides for the purchase from Mr. R. Ward (electrical engineer), of 9, Warwick Street, the following letters patent, Nos. 4,533 of 1887, 2,876 of 1888, 6,927 of 1888, and 6,988 of 1888. The purchase consideration is £299,930 (?) in fully paid shares. The vendor is appointed managing director at a salary of £1,000 per annum, but such salary is not to commence until the company has successfully floated at least one subsidiary company. Registered Office, 9, Warwick Street, Regent Street.

CITY NOTES.

The Western and Brazilian Telegraph Company, Limited.

THE report of the directors for the half year ended 30th June, 1888, states that the total earnings amount to £86,874 7s. 11d., as against £81,419 13s. 1d., an increase of £5,454 14s. 10d. compared with the half year to 30th June, 1887.

The working expenses, exclusive of renewals of cable, amount to £32,813 7s. 10d., as against £33,412 17s. 11d., a decrease of £599 10s. 1d.

Including the amount brought forward from 1887 (3,464 8s. 7d.) the balance to the credit of the revenue account is £57,525 8s. 8d., from which has to be deducted £13,500 for debenture interest, leaving £44,025 8s. 8d., of which £7,500 has been placed to the renewal fund, and £6,000 to the debenture redemption fund. This leaves £30,525 8s. 8d. The directors recommend the payment of a dividend on the ordinary shares for the half year of 2 per cent. or at the rate of 4 per cent. per annum, carrying forward £3,293 16s. 8d. At the corresponding period last year the dividend was at the rate of 2½ per cent. per annum.

The Direct United States Cable Company, Limited.—The board has resolved upon the payment of an interim dividend of 2s. per share, free of income tax, being at the rate of 2 per cent. per annum for the quarter ending 30th September, 1888, such dividend to be payable on and after the 24th instant.

Anglo-American Telegraph Company, Limited.—The directors have resolved to declare an interim dividend for the quarter ending 30th September, 1888, of 7s. 6d. per cent. on the ordinary stock, and 15s. per cent. on the preferred stock, less income tax, payable on the 1st November to the stockholders registered on the books of the company on the 9th October, 1888.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending October 12th, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,215.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th October are £2,482, as compared with £2,742 in the corresponding period of 1887. The June receipts, estimated at £5,484, realised £5,550.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending October 12th amounted to £5,061.

AMERICAN NOTES.

By DAS TELEPHON.

THE great copper trust appears to be world-wide, as has been proved by an enquiry before the "U.S. Senate Committee on Finance" into the operations in this country of the French Copper Syndicate. The committee examined the treasurer of the Copper Mining Company of Montana, also a treasurer of three Lake Superior copper mining companies, and also the counsel for the American agents of the "Société des Metaux" of Paris. Summarised, the testimony shows that the French company has a contract with all the copper-producing firms of the United States, which limits the production; that the French company takes all the copper produced here, sells it, paying the producers 13 cents a pound (equal to sixpence-halfpenny) and one-half of what is realised over that price when the copper is sold; that the French syndicate has the right at all times to fix the price of sale; that consumers buying copper of the syndicate or of the contracting companies, were required to agree not to put the copper on the market again, but to consume it in their own works. That, so far as known, no Americans are members of the syndicate.

It is sincerely to be hoped that this investigation will bring about the enactment of some one of the proposed laws against trusts of this kind.

Mr. Thomas A. Edison, our famous electrician, known throughout the length and breadth of this great unbounded continent as the Wizard of the North, has given to the public the results of his experiments in his researches for a preventive for that pestilential yellow fever which is desolating one of the largest cities of Florida, the flower garden of America. I send you a report of an interview lately with Mr. Edison, which may be interesting to your medical fraternity and to the electrical fraternity because of the renown of their famous American colleague in electrical matters.

"I cannot understand," said Mr. Edison, "how, in the face of the progress of modern science, nothing has been done to check the fever. Occasions like this are always productive of some discovery, and furnish a limitless field for experiment. But the people, as in preceding instances, take the fever and sicken and die. It is as yet unchecked, and instead of decreasing, is rapidly spreading. My experiments have been purely sentimental, and from the results obtained I feel confident that I have at last found a means of stamping out the fever germs. From my observation I am convinced that the fever germs must be either of two things—animal organisation or fungus growth. It is not due to gases, or the whole of a district would be affected at once. I believe that the fever microbe is parasitic, as it travels slowly along the ground and is known to have been stopped in some cases by street-paving.

"In 1878 I experimented to find some chemical to kill the Colorado beetle, and at last found that gasolene was immediately destructive to animal and vegetable matter. It is effective and evaporates in ten minutes, leaving nothing, so that all danger of combustion is soon passed. One-sixteenth of an inch of it goes 15 inches below the ground and kills everything. Rhigolene is a little dearer, but could prove valuable for quarentining purposes. Cold is an accepted exterminator of the germ, and both gasolene and rhigolene lower the temperature sufficiently to prove of value in treating the fever. I took an old woollen coat, tied up one of the sleeves to hold the thermometer, and then drenched it with gasolene. The temperature when the thermometer was first introduced in the sleeve was 82° Fahrenheit, but it gradually fell to 75°. After 30 minutes it fell to 52°. The same experiment was tried with rhigolene, and after 15 minutes the temperature fell to 23° and the coat was covered with hoar frost, so that had it contained any microbes they would have been thoroughly exterminated.

"Our experiments with microbes have been encouragingly successful, and not having any of the yellow fever germs to work upon, we can only draw our conclusions by analogy."

ON THE ELECTRICAL RELATIONS OF TELEPHONE AND ELECTRIC LIGHT AND POWER CIRCUITS AND RAILWAYS.*

By THOMAS D. LOCKWOOD.

This paper deals altogether with the disturbing effects of electric light and power currents upon the telephone lines, and not at all with the dangers of imperfect construction and insulation; nor with the results and prevention of dynamo current crosses, there being sufficient in the latter branches of the subject for a separate and equally voluminous paper.

It will consequently be assumed, for the purposes of this paper, that the important precaution of effectively insulating wires conducting heavy currents is observed, and that "undertaker's wire" is, as it ought to be, a thing of the past.

The Telephone Exchange business was commercially organised and established in the first months of 1878.

Electric lighting as a commercial industry had its beginnings in 1878 and 1879, but did not at first take root with the same degree of rapidity which characterised the exploitation of the telephone, and not until some years thereafter did it achieve popularity.

Consequently the telephone systems obtained a considerable start, and were finally established in nearly every city and town in the country before the organization of many electric lighting systems. It was not at the outset generally known that the telephone circuits would be annoyed by the presence and proximity of parallel electric light wires, and telephone companies were thus at first most liberal in permitting the erection near their lines of foreign lines carrying heavy and widely fluctuating currents.

Yet a little thought and consideration would have laid bare this danger. We knew that the telephone current was itself of the most shadowy and intangible character in point of strength, and that to utilise it, such a super-sensitive instrument as we all know the telephone to be, was actually essential; and we knew that *because* the telephone receiver was such a delicate electroscope, and so sensitive to electric motion; we had heretofore been much annoyed by mutual telephone induction, by telegraphic induction, and by miscellaneous induction. So, as I say, if we had carefully considered the matter, we might have foreseen the full extent of the electric light disturbance which is now being sustained.

But we did not foresee, and as a result of our lack of foresight indiscriminate construction has ensued; and, in consequence of improper construction, the business of many telephone companies has at certain points been directly or indirectly injured by the presence and operation of electric light wires, and an appeal to the courts has been rendered necessary.

Until within a comparatively recent period, the disturbance resulting from dynamo current induction was with an occasional and rare exception limited to certain evening hours, and to the night, because during such portions only of the day were the lighting circuits in operation. But of late, in many places, the wires used in the night for lighting are being also used during the hours of daylight for transmitting power from the dynamo to large numbers of motors which may be widely distributed; and as this utilisation is certain to have in the near future an enormous expansion, we are compelled to face the prospect that even during the hours of business telephone wires are now liable to severe disturbances; therefore, it seems time to call a halt; we could be patient as long as we were only called upon to suffer from "the pestilence that walketh in darkness;" but when we are also threatened with the "destruction that wasteth at noonday" it behoves us to have something to say about it. Super-added to the above causes we now find, to our cost, that many of them are much more active than are electric lighting circuits in setting up distributing currents in telephone lines; the distributing current from electric railways being frequently sufficiently strong to vitalise the annunciator magnets of a telephone central station, and to actuate the drops.

Now, I have no quarrel with electric light and electric railway companies considered as such. No man rejoices more heartily than I in the triumphs of electricity and in the tremendous spread of its usefulness. I recognise fully, moreover, that the lighting, power, and transit utilisations of this mighty form of energy are fully as useful as is its function of carrying intelligence, and that these utilisations have properly become permanent institutions, and, equally with our own, public conveniences. Nevertheless, we were first in the field, and, although we may admire both the energy of the electric lighting current and the energy of its introducers, we must in our own defence be prepared to take the position that no newcomer has a right to construct his plant in such a way that an established business shall thereby be ruined or impaired; and that, if it be absolutely necessary to erect electric light lines in proximity to telephone lines, the construction must be of such a character as not to involve detriment to the pre-existing telephone lines.

Can electric light and power lines be constructed so as to be near telephone lines without interfering with them? Certainly they can.

Consider how the disturbing currents originate:—First: most arc lighting currents can set up considerable induction on telephone lines.

Second: Alternating currents in main wires, whether used for arc or incandescent lighting, are intensely provocative of induction and noise in telephone circuits, the character of the disturbance being much worse than that which is produced by lighting currents of constant direction; this latter sounding in the telephones like a protracted musical note of great volume.

In speaking of the above it will be understood that the detrimental action upon telephones is the same when the dynamo current is used for motors as it is when used for lighting.

Third: Certain classes of electric railways very seriously interfere with the operation of telephone lines, both in conversation and also by establishing thereon a current which permanently excites the annunciator magnets. The noises which are produced in telephones by dynamo current induction are so well known that it would be waste of time to describe them.

When the troublesome currents are produced by electric light or motor circuits they may usually be attributed to induction although a certain amount of absolute leakage doubtless exists. Since, however, both causes produce in telephone circuits a like effect, it will be sufficient to speak of induction only. But if we consider the action of electric railways upon telephone lines, we find that the major part of the disturbance is due to the actual transference of a portion of the electricity which actuates the train motor to the telephone lines, by way of the rails (when these are used as return conductors), the crust of the earth itself, and the telephone line terminal ground wires.

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* Read at the Telephone Convention, New York.

As most of us know, the alternating current has received lately an increased amount of the patronage of our light producing friends; and at the present time both constant direction and alternating currents are largely used in electric lighting and power distribution circuits, the intensity of the disturbance varying with the class of current employed.

The violence of the induction, and therefore of the disturbance, depends upon the proximity and longitudinal distance of parallelism of the disturbing wire, the strength of the inducing current, the frequency or rate of change per time unit of the inducing current, and the extent or range of such change; that which is due to wires carrying alternating currents is, of course, much stronger than even the worst case of direct current induction, for even though the distance of exposure and the strength of the inducing currents be identical, it is self-evident that a current which is completely reversed a great number of times per second must be much more energetic as a disturber of the peace than one which is constant in direction and which varies only in strength on one side of the zero line.

These considerations indicate that our methods of prevention or cure should be directed at the stronger disturbing agency, since such a degree of success as we may be able to achieve against that will necessarily be equally effective as regards the weaker.

The proper way to cure or neutralise electric light or power induction *is to prevent it*. It is quite within the bounds of good construction so to relatively arrange the lighting and telephone circuit that no disturbance will result; and it is obviously much easier and less costly to construct them properly in the first place, than it is to change them. To secure this most desirable result, viz., the harmonious co-existence of these widely differing classes of electric service, I wish to point out that co-operation between the parties concerned is absolutely essential, together with a clear and full understanding of the conditions involved. Yet in many instances, though, as I have stated, the telephone wires were already in the occupancy of the field, telephone companies have negligently omitted to watch their own interests with sufficient care, and have without remonstrance permitted electric light companies to erect wires close to their own, and of such a character as to render inductive disturbance a foregone conclusion. Would not a general good understanding between the different electrical interests of any city or town be desirable for the forestalling of such chances of future disagreement?

Informal discussion, amicable conference and mutual consideration between the authorities of the several interests would tend to preclude any possible future misunderstanding, and would certainly act to prevent unnecessary antagonisms either between any of the several individual interests or with municipal authorities. A good understanding all round is therefore suggested, as being an admirable fore-runner to a system of non-conflicting construction.

Local managers of telephone companies should be instructed to report to headquarters at once the intended construction of either electric light or railway circuits at any point within their territory, so that proper measures can be concerted and adopted to meet the special conditions of the case.

If the general satisfactory understanding which I have outlined can be reached, it should not, I conceive, be difficult to bring intending electric light and railway officials to see that construction which is innocuous to their neighbours, and which, in virtue of the provisions necessary to secure such innocuousness, is thereby made safer in all respects, is (all things considered) both cheaper and better than construction which is at any time liable to involve them in trouble, misunderstanding and damages.

The element of distance is of the highest importance. Telephone and electric light wires cannot be too far separated for the efficient working of the former; and the wires last strung should be run, if possible, on other streets from those in which wires are already in operation. In no case ought the two classes of circuit to be nearer together than the width of an average street.

In writing the above I have not forgotten that it is oftentimes a matter of mutual convenience that reciprocal privileges shall be allowed. This idea is by no means in conflict with the general principle that distance is the most efficient neutraliser.

The good feeling and understanding which I have advocated will be productive of a tendency to keep down unnecessary pole construction, and if either interest have a pole line through a certain territory, and if the other party have but a few wires going in that direction, it is doubtless often the best policy and practice to make the existing pole line available for both. By suitable agreement on this head both telephone and electric light systems are enabled to use each other's poles on this occasion and thus to carry a sporadic line and accommodate a customer in districts which could not otherwise be reached, at least with due regard to economy. It is, of course, understood that an electric light company thus stringing wires on the poles of a telephone company must properly run its wires so as to produce at most a minimum disturbance; and that a telephone company taking its chance on electric light poles must not expect first-class results, unless it be returned through the region of disturbance. The responsibility in the latter case is on the owner of the telephone wire alone. If both sides of the street be fully occupied, and it should be really necessary to carry a main route of wires of both systems on the same side of any street, no other street being available—a state of affairs which ought not often to exist—it would, I should say, be better for them to be upon a single line of large poles, and thus to incur the enmity of abutters, property holders, municipal authorities and iconoclasts generally; for a uniform style of construction can then be adopted, and as the telephone current is the weaker, the telephone poles should carry both sets of wires and the construction should be supervised by its officials. This procedure is, however, only admissible if no other route can be found for the wires of that concern arriving last on the ground; and I repeat that wherever circumstances will permit, the width of an ordinary street at least should intervene between the wires of the two systems.

Electric light and power circuits ought always to be metallic; and, in fact, every self-respecting electric light circuit *is* metallic; this, however, being altogether without regard to its relations with contiguous circuits of other classes.

But a lighting or power circuit which is contiguous to telephone circuits must not only respect itself, but must respect the telephone circuits also, and hence must not only be a metallic circuit, but must have its two wires parallel and as close together as possible, so as to be practically equidistant from the telephone wires; this, in order that the inductive effect exercised by the outgoing and incoming wires may be equal and opposite.

Where the distance of the width of the street is observed, the parallel return wire frequently provides all the necessary neutralisation and presents disturbances, for the neutralisation is necessarily more perfectly effected as the distance of the two wires of the electric light circuit from the telephone wires is increased, because the distance of the two wires of the lighting circuit from one another is a much less factor in the greater distance, such as the width of a street, and the two wires therefore operate much less independently than is the case when each wire is almost as near to a group of telephone wires as it is to its own mate. It is, however, often also found (and especially when the two sets of wires are on different horizontal planes of the poles), that even though the two wires of the lighting circuit be substantially equidistant from the telephone wires, perfect neutrality and noiselessness is not secured; and the degree of remaining disturbance is greater or less, according to the distance between the wires of the two systems, and the distance that the said two sets run in parallel contiguity. This remaining disturbance manifests itself, because the electric light circuit is not balanced. If, for example, one of the two sides of a lighting circuit be made to serve one or more lateral loops, while the other runs straight; or, if one be connected with a greater number of lamps than the other, there is no balance; the electrical centre of the main line does not coincide with the mechanical centre, and one of the two sides exercises a much greater inductive influence than the other, the result being noise. By arranging the electric light circuit so that each side shall have an equal number of loops of like length, and an equal number of lamps or motors, and then by transposing or crossing the two wires of the lightning circuit about every fourth or fifth pole, the disturbance may be totally suppressed.

Such care in construction will most naturally be objected to by electric light and similar companies on the plea of expense, especially by such as have already constructed their lines in a style regardless of the rights of others; yet only by an insistence upon such conditions, when the two systems of lines are in close proximity, can the business of telephone companies be protected.

It may also be objected that since the parallel return wire, cross-connected at intervals with the out-going wire, is a remedy for inductive disturbance, it is one which should be applied by the telephone companies, and to the telephone circuits, as being the complaining party. But as to this, in addition to the already stated fact, that in nearly every case where the pernicious effects of induction are experienced, the telephone company was already in business, and its wires in place, and that the disturbance originated with the advent of the electric light wires, and that common justice requires that the aggressor should apply the remedy, it may with reason be rejoined that the number of the electric light wires is much less than that of the disturbed telephone wire, and therefore, the remedy may be applied to the former with much greater ease, and at much less expense.

We have considered the preventive or remedial measure which are applicable to this evil; and it seems clear that the right time for suggesting the propriety of observing these conditions of neutral construction is before the work has been done, and it is probable that the owners of disturbing wires will be much more willing to heed them, in originally arranging their wires, than where subsequent alteration is required, especially as in original construction the plant suggested would not necessitate the numerous joints inseparable from later transpositions.

In any case, whether such remonstrance and suggestions as may be offered tending to harmless construction be properly received, and acted upon, or not, it is our duty to offer them, and so to place ourselves in the right, and in the unmistakable position of having at least done our part in objecting to *improper*, and in stating our conviction of what constitutes *proper* construction.

I have already alluded to electric railways and to the fact that the weight of evidence in regard to disturbances developed by them upon telephone lines tends to show that these are due not to induction, but to actual conduction of electricity from the railway conductors to the telephone lines.

There are several classes of electric railway.

1. Those which utilise the rails for both outgoing and return conductors.
2. Those which employ a single overhead conductor using the rails as a ground terminal or return.
3. Those in which the two main conductors are both in a conduit, to which access is had through a slit, in the same way as a mechanical cable road is operated, trailing brushes or springs being led through the slit.
4. Railways which carry their own electrical energy in the form of secondary battery cells.
5. Railways which employ two overhead conductors, one as the outgoing and the other as the incoming line.

Of these plans the first and second are very detrimental to the satisfactory operation of telephone lines; the fourth is perfectly harmless in all respects; and the third and fifth usually are also, and may be readily so made when they are not. All that is necessary to that end is to exercise such care in construction as to ensure that the main conductors are properly insulated, and in the case of the fifth plan that the main conductors are also prevented from coming into contact with overhanging branches of trees.

A great number of electric railways are built upon the second plan, and where they run near the telephone lines invariably exert a pernicious influence thereon, which is largely due to the imperfect return on earth terminals furnished by the rails, a portion of the current passing from them through the earth to the telephone circuits by way of the sub-station ground wires, this occasioning interference with conversation and affecting call signal apparatus, and often damaging property.

This class of construction is manifestly improper, both on the score of interference with the telephone wires and as being dangerous; and is of the cheap and reckless order.

When the remedies for its evils are so simple, and consist merely in adding a second overhead conductor, and in looking well after insulation, it would seem that they should be properly and universally applied by reason of the greater security they afford, even though those owning railways may have no just regard for the rights of others.

Telephone companies should therefore exert themselves and their influence in favour of the double overhead wire and other safe forms of railway, the former being, in fact, safer in other respects, and more economical in operation than railways which in any way utilise the rails as conductors.

Where other systems are already in use, and should it be found impossible or impracticable to persuade the railway companies to provide a return wire, and where the telephone service is consequently impaired, the only absolute and radical remedy is that of providing the telephone circuits which are affected with a parallel return wire.

The disturbances may, however, be greatly softened down or subdued by carrying the ground end of the subscriber's wire from his office or house to some point at a considerable distance at one side or the other of the railway and by there terminating it, instead of at the sub-station itself. Considerable success has also been attained in practice in the amelioration of this trouble, by connecting the leading out wires of a number of neighbouring disturbed telephone lines with a large common return wire grounded at or near the central station, instead of grounding each in the ordinary way.

If the leakage is so great as to affect the annunciators, it is sometimes requisite that the common return wire, instead of being grounded, shall be connected with the several central office terminals of its group of lines, exactly in the same way that its outer end is united to the outer end of the individual lines; that is, of course, when these are at rest. By adopting this plan, the earth connection is, when the lines are not in operation, completely cut off. If the disturbance does not affect the talking, ground connections can be provided for use during talking. If it does, then the return must be retained during talking also.

Though this paper is already long, there are still one or two points on which I should touch. In one of the children's hymns composed by the late lamented Dr. Watts, occur these lines:—

"One sickly sheep infects the flock,
And poisons all the rest."

And upon the principle thus enunciated, it not infrequently happens that though but few telephone wires, or even but a single wire, be exposed to disturbance originating in and by the causes recited, the trouble is propagated to others by induction by reason of the close massing of large numbers of wires at or in the vicinity of central stations.

Consequently one wire adversely affected by electric light or railway disturbance may influence deleteriously many others.

The lessons we have to learn from this are, that if we have one wire so affected, we ought in some way to promptly attack the evil in that one wire, remedying the trouble while it is small and controllable, and that it is essentially our duty to remove dead or unused wires at once, unless there is good reason to anticipate an early resumption of use; and even then they should be disconnected from the two terminal stations, and when I say disconnected, I don't mean simply short circuited or cut out, but absolutely detached, dead wires being one of the most prolific and active agencies of disturbance and danger.

True, it costs something to take down wires, and it may be troublesome to put them up again when required, but it is the only safe proceeding, and in such matters the anchor ought to be cast to windward every time. It is better to spend a few cents in defence than it is to spend possible millions on account of the misdoings of a dead wire in tribute.

Finally, if the number of disturbed wires be smaller than that of those causing the disturbance, or if it be necessary to run a telephone wire through a region of disturbance, the simplest, easiest and most economical way is not to monkey with the buzz-saw, but at once to make the telephone circuit metallic, at least through the region of disturbance, which operation should, moreover, be invariably performed in cases where less drastic measures fail.

NOTES ON TELEPHONE BATTERIES.*

By A. F. PICKERNELL.

I SHALL not attempt in these notes to recommend or describe any particular battery, but shall content myself with pointing out defects existing in the batteries now commonly used for transmitters, and emphasising the importance of certain features which all telephone batteries ought to possess.

The selection of batteries for transmitters has always been a matter of considerable importance, although not always recognised as such. When the battery transmitter was first introduced nearly all telephone wires ran on overhead structures, no cables being used. The retardation in these circuits was consequently slight, and it was during this period of the business that the large margin in transmission was observed, it having been found possible to talk with the same ease over circuits 50 miles long as it had previously been over circuits a mile longer. This led naturally to poor construction, lines being built with small gauge iron and steel wire, and in many cases without insulators. Such construction cut down this margin of transmission to such an extent that it was found impossible to talk over such lines in bad weather unless the transmitter and battery were in the very best condition.

Better construction followed, and with better construction the battery problem was of less importance. More recently, however, the extensive introduction of cables has again cut down the *margin* of transmission. This, of course, renders it necessary to keep the transmitter and its battery in better condition. As the cable system of any telephone exchange increases, in a like ratio will the importance of battery problem increase. It was only last week that a gentleman was telling me of his experience in confirmation of this. His company had a cable 2½ miles long which not only had a high electro-static capacity, but also a high resistance. This cable was used mainly for trunk wires. It was noticed that many subscribers who had no difficulty in talking with parties in their own exchange, had considerable difficulty in talking with parties in the other exchanges connected through this cable. Upon inspection it was found that invariably a poor battery was found at the subscriber's instrument. This cable made a very good battery inspector, and one, I may say, that did not ruin the transmitter in inspecting.

The battery most commonly used for transmitters is of the Leclanchè form. The little attention required by a battery, this class, its freedom from violent acids, the ease with which it is set up, its small consumption of zinc, there being no consumption when the battery is on open circuit, all unite in making it the leading form of telephone battery. However, it polarises rapidly, and has a high and constantly increasing internal resistance when worked over a low resistance circuit, as it invariably is when used for transmitters. The importance of low battery resistance is shown clearly by the following considerations:—

The efficiency of any transmitter, other things being equal, is proportional to the variation in current strength produced in its primary circuit. The greater the variation in current strength the greater being the efficiency. The variation in current strength being proportional to the variation in resistance, it follows that the efficiency of any transmitter is proportional to the variation of resistance produced in its primary circuit. The following table, calculated for a Blake transmitter, shows how important is the part battery resistance plays in modifying this variation in resistance; in other words, in modifying the efficiency of the Blake transmitter.

This table assumes the variation in a Blake transmitter to be from 5 to 15 ohms, these figures being the result of many measurements.

TABLE FOR BLAKE TRANSMITTERS. RESISTANCE OF PRIMARY CIRCUIT OF INDUCTION COIL ·5 OHMS.

Battery resistance.	Minimum resistance.	Maximum resistance.	Ratio of minimum to maximum.	Percentage decrease of ratio from that of battery of resistance.
·0	5·50	15·50	1 : 2·83	...
·33	5·83	15·83	1 : 3·72	3·3
·57	6·17	16·17	1 : 2·62	7·1
1·00	6·50	16·50	1 : 2·54	9·9
1·33	6·83	16·83	1 : 2·46	13·8
1·67	7·17	17·17	1 : 2·39	15·2
2·00	7·30	17·50	1 : 2·33	17·4

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* Read at the Telephone Convention, New York.

Two ohms is not an uncommonly high resistance for Leclanché batteries, and from the table we see that the variation from its minimum resistance to the maximum resistance of the primary circuit of a Blake transmitter decreases from a ratio of 1 : 2·72 in the case of a battery of ·33 ohms internal resistance to a ratio of 1 : 2·33 in the case of a battery of 2 ohms resistance, a decrease of 14 per cent.

With L. D. transmitters the battery resistance is an even more important factor, as will be seen by the following table :—

This calculation for long distance transmitter assumes variation in resistance to be from 4 ohms to 20 ohms, resistance of primary of induction coil ·45 ohms.

Three cells of Leclanché batteries are generally used with this transmitter.

Battery resistance.	Minimum resistance.	Maximum resistance.	Ratio of minimum to maximum.	Percentage decrease of ratio from that of battery of no resistance.
·0	4·45	20·45	1 : 4·60	...
·33	5·45	21·45	1 : 3·94	14·
·67	6·45	22·45	1 : 3·48	24·
1·00	7·45	23·45	1 : 3·15	32·
1·33	8·45	24·45	1 : 2·89	37·
1·67	9·45	25·45	1 : 2·69	42·
2·00	10·45	26·45	1 : 2·53	45·

From this table we find that the variation is decreased from 1 : 3·94 when batteries having internal resistance of ·33 ohms are used to a ratio of 1 : 2·53 when batteries of 2 ohms internal resistance are used.

These tables likewise show why it is that even a slightly defective joint in the primany circuit prevents the action of the transmitter.

Polarisation is a defect of even more importance than internal resistance. It is not uncommon for a Leclanché battery to decrease 30 per cent. in E.M.F. after 10 minutes' use. This, of course, decreases the average current in the the primary circuit of the transmitter in a like ratio.

Having noticed now the importance of low and constant internal resistance and constant E.M.F., I will next call attention to some of the causes which operate to render telephone batteries not only poor to start with, but unreliable in service. Lack of porosity in the porous cups is frequently the cause of high battery resistance.

Commonly porous cups are found which contain peroxide of manganese dust. This dust should never be admitted, as it invariably increases internal resistance. The peroxide should be in particles about the size of small peas. Binding posts are frequently found which do not make good connections with the electrodes. The binding post on the carbon plate is often found after a few months' use to be almost entirely insulated from the plate. This is caused by the salts creeping up through the carbon and corroding the metal binding post. The upper portion of the carbon is supposed to be entirely impregnated with paraffin to prevent this crawling, but very often the carbon is not *soaked* long enough to become thoroughly saturated. Care must be taken not to use an excess of sal ammoniac in setting the battery up, for otherwise crystals will form on the zinc, increasing very much the internal resistance. If the sal ammoniac becomes impoverished, a complicated chloride of zinc will deposit in the same manner.

A poor quality of the peroxide of manganese is frequently found in porous cups. When such is used polorisation takes place very quickly.

Gravity batteries and bichromate of potash batteries have been used to a considerable extent, especially for L. D. transmitters, These batteries require much more attention than the Lechanché battery and are not so reliable. The battery which in its electrical properties approaches more nearly the ideal battery is the storage battery. This combines constant E.M.F. with very low internal resistance. Two cells of storage battery on an L. D. transmitter give the very best transmission.

This form of battery cannot, of course, be generally used on subscribers' instruments.

Many modifications of the Leclanché battery have recently been introduced, some having remarkably low resistance, but they all polarise more quickly than is desirable. I think that if we have not already a modified Leclanché battery that combines low resistance with constant E.M.F. that we will soon have one, and this will be beyond question the telephone battery of the future. I see no reason why a battery of this kind could not be made, having an internal resistance of considerably less than ·5 ohm and a constant E.M.F. of 1·48 volts. This battery could be put up in a package with nothing but the terminals projecting, and these, I may say, should be provided with the best possible forms of binding posts. By using nothing but the best material and properly designing the electrodes, polarisation could, to a very great extent, be prevented, and by properly proportioning the components exhaustion would take place in all the parts at about the same time. Such a battery would give, when set up, the very best possible results, and would require no inspection. When the battery became exhausted no unsatisfactory doctoring would be done by the inspector; he would simply replace a battery by a new one. Until some such battery is generally introduced we may expect about the same percentage of battery troubles as we are now having.

ALTERNATING v. DIRECT CURRENTS—A REJOINDER TO MR. BROWN.[*]

By P. H. VANDER WEYDE.

MR. HAROLD P. BROWN, in his defence against my criticisms on the experiments made by him during his public lecture, begins with giving the official report of further experiments made afterward before members of the Board of Health, which report, as he states, has not been published by any of the electrical papers, and which he therefore allows that I have not heard of. This is so; my remarks were the simple result of the impressions I received while attending the lecture to which I had been invited. For my part, I am ready to allow that if I had been present at the subsequent experiments my impressions might have been different, but because of the way our controversy stands now, I have to confine myself to what I have seen and commented upon.

Before going into a specific consideration of Mr. Brown's attempt "to set me right in matters in which I am greatly mistaken," I wish to state that I am in no way whatsoever connected with any alternating current interest, as he insinuates, neither am I interested in introducing a "new and peculiar converter." This apparatus was simply made by me as a tool for further researches of my own. It is based upon the peculiar form of Roberts's powerful electro-magnet (see Sturgeon *Ann. of Elec.*, vol. 6, p. 166) which I made some 30 years ago, and which, by evolution, was changed first into a current generator for telegraphic purposes, and recently into a converter.

I wish also to state that circumstances caused me to write down my impressions in haste, and that from my first rough draft copies were made in type-writing and delivered without my knowledge; the editors of the *Electrical World*, in their praiseworthy desire to give an early report of the meeting, had my paper in type before it was read, and in which I had corrected some of the statements to which Mr. Brown objects. It was only on the day after the reading of the paper that I found this out, and all that I could do was to correct some clerical errors in the figures. I was informed afterward that other type-writer copies were in the hands of Mr. Frank L. Pope, and calling at his office and communicating the circumstances to him, he requested me to correct one of these for his paper, the *Electrical Engineer*, which, being a monthly, allowed time for correction, while I gladly accepted the opportunity to obtain a record of my paper as I intended it to be. The number of the *Electrical World* containing Mr. Brown's defence reached me yesterday by the same mail as the *Electrical Engineer* containing the corrected version of my paper, of which, however, the bearing remains practically the same, namely, to show that the experiments exhibited at Mr. Brown's public lecture were not conclusive to prove that the voltage of the alternate current used was not higher than it was estimated, or what the instruments appeared to indicate, which doubt is based upon the use of an entirely different principle in the measuring instruments of either current.

In regard to these, Mr. Brown asks me to tell him wherein voltmeters of the ordinary type differ from ammeters, except in their resistance and calibration. I will satisfy his request by saying that the principal difference is in the number of convolutions of the conducting wire; while ammeters have only a few, one or even half a convolution, the number of convolutions of the voltmeter run in the hundreds and thousands, by which the magnetic action of the electromotive force upon the galvanometer needle or upon the movable iron core is multiplied. The greater resistance of the voltmeter is simply a necessary consequence of this.

If the difference were one of resistance solely, we might as well substitute a single high resistance loop of very thin German silver wire for the low resistance copper strip or bar of the ammeter, in order to change this into a voltmeter.

Mr. Brown advises me to write for information to "Prof. Forbes, who has time to keep posted on current inventions." Well, I saw Prof. Forbes when he exhibited his ammeter, or rather coulombmeter, before a meeting of the American Institute of Electrical Engineers, where I pointed out to him some grave defects in his apparatus, as well as the manner in which it could and should be corrected. My remarks were endorsed by many members present, but, as is commonly the case, not by the inventor.

I may not have "time to keep posted on every current invention," but I have had time to construct and experiment with voltmeters based on rise of temperature, which labour has caused me to lose confidence in voltmeters based on that principle. When I can be shown a voltmeter of this class which will indicate 30 volts when on a current of 24 large Daniell cells connected in series, and only one volt when on the current of a large coiled up Wollaston plunge battery of, say, a few metres square surface (as will be the case when using a voltmeter with a magnetic needle), I will be convinced that the caloric principle can be applied to voltmeters. However, as far as my experiments have gone, I have found that the direct indications of such voltmeters are only correct when used in circumstances similar to those under which they have been calibrated, and that under other conditions the indications have to be corrected by taking in account the mutual relations of the external resistances to those of the internal resistance of the battery or current generator employed, and of the measuring instrument itself.

I expected I should be taken to task for heresy in regard to my want of faith in caloric voltmeters, even when they have been invented in England. What are they? Nothing but metallic thermometers calibrated for voltage. I abandoned the use of such thermometers long ago, as I found them, by reason of their necessary mechanical complication (pivoted gearing, &c.), more or less unreliable, frequently failing to return to the starting point when allowed to cool down, in the course of time changing their indication entirely, &c.; hence my unfavourable opinion about them, and all contrivances based upon the principle. However, when well made and carefully used, they may, when graduated as ammeters, give tolerably correct readings, even for currents of great quantity; but when graduated as voltmeters they are subject to the difficulty that there is a great difference in the caloric capacity of currents of high electromotive force with low quantity of current, and the reverse circumstances, so that an instrument graduated by very high voltage and low current cannot give correct readings for low voltage and high current.

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[*] *Electrical World.*

I had heard of Cardew's voltmeter, but only from the meagre account given in Prof. S. P. Thompson's book, referred to by Mr. Brown. In looking up some of the authorities Prof. Thompson refers to in a foot-note, I see that my objection against complicated mechanism, such as pivoted gearing, &c., applies to the voltmeter of Cardew as well as to others. The fine wire used in it makes it only adapted to currents of a limited range of voltage, while it is utterly unadapted to currents of low electromotive force, such as 30 volts and below, because it absorbs a great deal of electric energy. Consequently there is great uncertainty at the lower end of the scale, while at the upper end the uncertainty is so great that the inventor found it necessary to double the resistance as soon as the voltage reached 120 volts, and then attach another scale to read the volts for this higher resistance. (See Ayrton's "Practical Electricity," London, 1887, p. 427.)

Another question must be settled also, namely: how far is the caloric effect of a current influenced when the same direct current is caused to alternate. Will not the alternation reduce the caloric effect and consequently indicate a lower voltage, when a voltmeter is employed, based on the principle of rise of temperature? Some of my experiments seem to point this way. I say *seem to point*, as my tests have not been made with sufficient frequency to settle the point in my mind, but I recommend investigation of this kind to those interested.

NEW PATENTS—1888.

14156. "Improvements in the precipitation and the mechanical, chemical, pneumatic, and electric treatment of towns' sewage, and the utilisation of the solids therein as well as the preparing from towns' refuse a deodorising and purifying power, which is also applicable for other purposes." W. Y. Hardie. Dated October 2.

14161. "Improvements in the method of producing electromagnetic inductions for transformers, motors or generators, and in the apparatus therefor." L. Bollmann. Dated October 2.

14184. "Improvements in obtaining electricity for electric lighting, motive power, and other purposes." W. Boggett. Dated October 2.

14191. "An apparatus for automatically transmitting electric currents." S. R. Lowcock. Dated October 3.

14226. "Improvements in and relating to continuous current dynamo-electric machines and electro motors." R. Dick and R. Kennedy. Dated October 3.

14230. "Improvements in electricity meters." J. S. Raworth and W. M. Mordey. Dated October 3.

14322. "An improved galvanic cell or battery for electric lighting, or for other purposes." S. Miller. Dated October 5.

14323. "An improved electrolyte or depolarising solution for galvanic batteries." S. Miller. Dated October 5.

14383. "An improved electric switch." J. Hauser. Dated October 6.

14426. "Improved electrical connection." C. S. Snell. Dated October 8.

14456. "Improvements in telemotor apparatus, or apparatus for working steering, telegraphing, indicating, and other apparatus from a distance." A. B. Brown. Dated October 9.

14472. "A galvanic action or current for the cure of toothache." W. Griffin. Dated October 9.

14489. "Improvements in electric lighting." E. R. von Nollendorf. Dated October 9.

14492. "Improvements in electrical signalling, indicating or registering apparatus for railway purposes." J. B. Sutherland. Dated October 9. (*Complete.*)

14499. "Electric light switches." H. Swan. Dated October 9.

14522. "Improvements in galvanic batteries." D. Humphreys. Dated October 9. (*Complete.*)

14542. "Improvements in electric and other bells." R. W. H. Newington. Dated October 10.

14600. "Improvements in the cores and armatures of electric bells, relays for electric bells, railway signalling bells, and electrical indicators." G. H. Bassano. Dated October 11.

14611. "Improvements in or relating to apparatus for driving electric railway or tramway cars." J. Monteith. Dated October 11.

14612. "A marine telpherage system." J. Monteith. Dated October 11.

14622. "Variable adjustable resistance for electrical currents." E. G. Craven. Dated October 11.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1887.

10200. "Improvements in dynamo-electric generators and motors." H. C. Bull & Co., and H. C. Bull. Dated July 21. 8d. Claims:—1. In dynamo-electric generators or motors, magnets constructed with cores consisting of a metallic piece and a piece of non-conducting substance, such metallic and non-conducting pieces being wound with a wire coil and a second metallic piece placed outside the said coil and against the non-conducting piece; as, or substantially as and for the purposes set forth. 2. The dynamo-electric generator or motor, described with reference to the drawings, consisting essentially of a series of magnets, constructed as described, and a rotary cylinder; operating and constructed as or substantially as set forth.

10663. "Improvements in or relating to electrical type writers and printing telegraphs." A. J. Boult. (A communication from J. F. McLaughlin, of Philadelphia.) Dated August 2. 1s. 1d. Relates to an electrical type-writer capable of being used either as an independent local electro mechanical instrument or as a receiver in conjunction with a suitable transmitter for printing telegraphs. The claims are 26 in number.

10836. "Improvements in electrical firing mechanism for ordnance." C. A. McEvoy. Dated August 6. 8d. Claims:—1. Carrying within the breech blocks of breech loading guns a coil of insulated wire of comparatively high resistance and a conducting pin or rod for conveying an electrical current to the primer of a cartridge, which pin or rod is normally held back by a spring so that its end does not come into contact with the primer, but when an electric current is passed through the coil is drawn forwards and its end brought into contact with the primer, and the current then passed direct through the pin to the primer without passing through the coil. 2. The construction of the firing mechanism for breech loading guns substantially in the manner described with reference to the drawings.

11543. "Improvements in electrodes for electric accumulators or secondary batteries." H. Tudor. Dated August 24. 8d. Claims:—1. A battery plate for electric accumulators or secondary batteries having symmetrical ribs or grooves straight or curved and with sloping slides, substantially as described and shown in the drawings. 2. The application of furthur oxide of lead on the surfaces of leaden electrodes of any form previously covered with a layer of crystalline oxide of lead according to the method of Mr. Gaston Planté. 3. The special form of the grooves set forth which are bent down or spread out as shown in the drawings for the purpose of reliably holding the lead oxide in place and preventing it from detaching itself from the plate.

11802. "Improvements in and relating to the manufacture of incandescent lamps." A. Shippey. Dated August 31. 8d. Its chief objects are to reuse and make up spoiled or damaged lamps, repair same and convert old lamps into new, by utilising the waste materials used in connection and combination therewith. The claims are 7 in number.

12208. "Improvements in dynamo-electric machines." T. L Hemming. Dated September 9. 8d. Claims:—1. The invention as illustrated and described for the purpose described. 2. The combination of the H shaped blocks with the connecting rods, discs, mica plates, spindle-discs and coil, in conjunction with the casing in the manner illustrated and described, for the purpose described.

12414. "Improvements in electric arc lamps." F. C. Phillips and H. E. Harrison. Dated September 13. 8d. Relates especially to focussing arc lamps, that is lamps in which both the electrodes are moved so as to keep the position of the arc approximately constant. There is one claim.

12823. "Improvements in telephonic arrangements or systems especially adapted for intercommunication in houses, offices and the like. A. A. Campbell-Swinton. Dated September 21. 8d. The arrangements or systems are employed in connection with direct acting telephones wherein the transmitters, receivers or the single instruments that may serve for both receiving and transmitting batteries, if any are used to actuate the telephones and line wire are all in the same circuit, and are such that a number of stations can communicate each with either of the others, no central station being required. The claims are 4 in number.

13338. "Improvements in electric lamp attachments." W. Hartnell. Dated October 3. 8d. The object of this invention is to provide an improved means of placing and retaining a shade or reflector surrounding an ordinary electric lamp in different positions so as to throw the light accordingly. The claims are 5 in number.

13558. "Improvements in or relating to casings for electrical conductors and apparatus." P. EVERITT and P. R. ALLEN. Dated October 6. 8d. According to the invention, between the grooved strips containing the leads or conductors, or the edges of the cases containing the instruments and their covers, are placed strips or gaskets of India-rubber or other suitable packing material, so that when the said covers are screwed or tightened down the said strips or gaskets will be compressed. The claims are 4 in number.

13709. "India-rubber compensators for telegraph, signal, and other wires." R. S. BOZON. Dated October 10. 8d. The inventor affixes to telegraph, signal, and other wires, or between the insulators and posts of telegraph and other wires, India-rubber cushions between compressors so arranged that any variation in the wires, caused by constraction, expansion, weight of snow, pressure of wind, shocks, or any undue strains, is compensated by the compressors being drawn in opposite directions against the ends of the India-rubber cushions, which yielding by their elasticity compensates any strains upon the aforesaid wires. The claims are 3 in number.

13978. "Improvements in electric firing gear for rapid firing and other guns." A. NOBLE. Dated October 14. 11d. The objects attained by this invention are:—1. Increase of safety in the stowage of ammunition where the powder case and projectile are made up together, as in rapid-fire guns. 2. Rapidity of fire and avoidance of necessity to cock the gun. 3. Simplicity of the breech mechanism by the avoidance of the cocking. 4. Absolute security against firing the gun prematurely or before the breech is closed; this is attained by arranging the unlocking of the breech screw to break contact with the battery, and to make contact to earth with the firing needle. The claims are 5 in number.

14024. "Improvements in secondary batteries or electrical accumulators." N. DE BERNARDOS. Dated October 15. 8d. Claims: 1. A secondary battery or electrical accumulator having plates or elements in the form of frames filled with alternate zig-zag and straight strips of lead soldered to the frame at their extremities, the zig-zag strips being creased or bent on lines oblique or inclined to the centre line or direction of the length of the strip, all substantially as described and illustrated in the drawing. 2. A secondary battery or electrical accumulator having plates or elements constituted by lead frames filled with straight strips of lead alternating with strips bent in the form of a zig-zag by creases in lines running obliquely to the direction of the length of the strip, the said frames being supported or suspended in the trough or vessel by arms or projections bearing on the sides of the said trough or vessel, substantially as described with reference to the drawings. 3. The combinations and arrangements of parts forming an improved secondary battery or electrical accumulator, substantially as described.

14029. "Improvements in electrical tramways and railways." F. C. ALLSOP. Dated October 15. 11d. Claims:—1. In electrical tramways or railways, the method described of transmitting electrical energy to a motor on a car or other vehicle, the said method consisting essentially in the employment of a collecting arm with rollers adapted to work on a flexible conductor supported on insulated arms, the conductor merely resting on the arms and not fixed thereto, substantially as described. 2. In electrical tramways or railways, a conduit for containing the conductor and insulators, the said conduit consisting essentially of a channel or trough in which is placed a tramrail or other suitable division plate, in such a position as to divide the channel into two parts, the one having a continuous slot in the top and the other a much wider opening, in which is fitted a movable lid, substantially as described with reference to the drawings. 3. In electrical tramways or railways, the employment of two channels, the one for containing the insulators and the other for the main conductor, substantially as described with reference to the drawings. 4. In electrical tramways or railways, the employment of an auxiliary conductor, the said conductor feeding the main conductor at each insulated support, substantially as described. 5. In electrical tramways or railways, the combination of insulators and supporting hook, substantially as described. 6. The improved electric tramway or railway described and represented in the drawings.

14247. "Improvements in dynamometers." W. PARKINSON. (Communicated from abroad by J. Wallace, of Bombay.) Dated October 20. 8d. The inventor employs a wheel with flexible arms, each arm consisting of two or more flat springs, which are interchangeable. Their number may be varied by additions or removals, to suit various powers. These springs are held rigidly in suitable jaws upon the boss of the wheel and their outer ends are held loosely by the rim of the wheel. The rim has a rotary movement upon the boss, limited by stops in either direction, which prevent the springs from being overstrained. On the boss of the wheel is a radial arm to which a pencil or stylus is affixed. This arm travels by means of a differential motion along the boss, but its angular movement corresponds exactly with that of the boss of the wheel. The driving power being made to pass through the rim of the wheel, to which a card is attached by means of a suitable card-holder. The pencil or stylus draws a diagram across the card, which measures all the angular differences of position between the boss and the rim during the period of the experiment. The power in foot-pounds absorbed by the machine is ascertained after it is stopped by hanging a weight on the periphery of the wheel until the pencil reaches the mean height of the diagram curves, and then multiplying the weight into the speed in feet per minute of the periphery. Claim:—The means used, as described and set forth in the drawings, of causing the pencil to travel across the card in combination with the flexible arms of the wheel.

14416. "Improvements in telephonic apparatus." J. L. CORBETT. Dated October 24. 8d. The inventor introduces a local battery current to reinforce the telephonic impulses transmitted to the receiver, or to increase the magnetism of an electro-magnet in the receiving instrument. The claims are 4 in number.

14954. "Improvements in apparatus to be used in the deposition or treatment of metals by the electrolytic process." W. TERRILL. Dated November 2. 6d. Claim:—In apparatus to be used in the deposition or treatment of metals by the electrolytic process, the application and use of lengthened columns of liquid or syphons to carry on the circulation, substantially as and for the purposes set forth.

CORRESPONDENCE.

Lightning.

I was sure that Mr. Varley intended no offence; but at the same time to accuse a man of distorting facts to fit theory, which he appeared to do in his previous letter, is tantamount to an accusation of dishonesty. If he only means that I have selected such facts as best illustrate a theory I am trying to expound, and in that sense have fitted facts to theory, that is no doubt exactly what I have tried to do in the articles on "Modern Views of Electricity," which were written entirely for elucidatory purposes.

In the case of the lightning conductors, however, I started with practically no theory at all, and a fortnight before the lectures did not in the least know that I was not going to uphold all the conclusions of the lightning rod conference almost in their entirety: going, however, into the question of self-induction, which they had not done, giving an emphatic condemnation of iron, and singing the praises of copper tape. The experiments I made in the fortnight preceding the lectures led me by the nose completely, and it was a very short time before giving the second lecture that I saw, or thought I saw, the explanation of most of them. Quite likely that I only partially see the explanation of some; quite possible that I erroneously fancy I understand others. I can have no possible objection to any amount of well-founded animadversion on such scores as these.

Repetition and correction of the experiments, more complete and thorough explanation of any apparently anomalous results, will be most welcome.

Now Mr. Varley objects to my last letter because it does not attempt to refute him. I never set myself to do so, I merely answered the direct adjuration contained in his last paragraph. A casual letter scarcely seemed a suitable place for beginning a refutation, even if I saw anything specially calling for that operation. I must say, however, that when I mentioned the pendulum or spring analogy, I had entirely forgotten that Mr. Varley had made use of it himself. It is an old analogy, first employed virtually by Helmholtz in 1850, and several times later by other writers; and I merely suggested it as sufficiently indicating to Mr. Varley what people thought was the nature of the oscillations. Had I remembered that he used it himself I should certainly not have been guilty of the discourtesy of trotting it out in that unnecessary manner.

I now see that what Mr. Varley really wanted to know was whether I agree with him that "oscillations involve matter." Inertia they certainly involve: electrical inertia if nothing else; real inertia as I believe. Whether inertia and matter are regarded by Mr. Varley as separable or inseparable ideas I do not know. To my own mind they appear fairly inseparable.

Mr. Varley goes on to express the opinion that I have not yet completely explained the experiment of the alternative path. He is quite right. In print I have only partially done so: some M.S., which will appear soon, goes further, but there are one or two points of which the explanation is still possibly incomplete. He suggests brush discharge. Other suggestions have been made, all worthy of consideration. I do not myself think the brush discharge suggestion is a solution of the difficulty. But the whole matter must receive fuller treatment elsewhere.

The iron bundle experiment Mr. Varley still chooses to reject, on account of a hypothetical short circuit; so that, according to him, when I say the discharge goes round the tinfoil spiral it is really doing nothing of the sort, but merely jumping across; and that is why I observed no extra obstruction from the presence of an iron core.

This would be a wretched way to make experiments. The experiments published are merely a selection from a great number made. The experiment on the effect of iron as the core to a circuit conveying a Leyden jar discharge, so soon as it resulted in a negative, had to be repeated in all manner of forms before publishing it as a definite experimental result. It was tried with a closed iron circuit, after the manner of an alternating transformer, and in many other ways.

I was in no sense guided to the result by theory. Experiment again led me by the nose. The tinfoil spiral was one of the last forms into which the experiment was thrown. A glass tube with an open bare copper spiral, the turns nearly ½ inch apart, does just the same. There is no possible question of a jumping across. The discharge certainly goes through the spiral; and yet the presence of an iron core does not shorten the spark which may occur in the air-gap alternative to the spiral. Its presence does, however, diminish the noise of the main discharge.

What the explanation may be I prefer to leave for the present an open question. The facts are so.

Oliver J. Lodge.

October 14th, 1888.

The Blackpool Electrical Tramline.

Your readers will no doubt remember the correspondence which took place about 12 months ago in regard to the working of the Blackpool Electric Tramway, when I gave it as my opinion that the breakdown (which was then most complete, the tramway being entirely stopped), was entirely due to the defective class of insulator which had been adopted by Mr. Holroyd Smith. I explained at the time that I was designing a new insulator for the line, and it may interest your readers to see an extract from a letter which I have received from the managing director, and which I trust you will be good enough to publish.

J. Slater Lewis.

October 15th, 1888.

[EXTRACT.]

I am pleased to tell you that our line was never so good before. In fact, we test it every night, and always find the leakage *nil*. It appears to be almost impossible to have two miles of line without leakage; but, nevertheless, practically speaking, it is so, and we are running beautifully, averaging 3,000 miles per week. Of course the whole of the line is insulated with your insulators, and when the season is over I shall have one in every yard. We have now nine cars constantly at work, and can only say that we are delighted with the results.

Electrical Distribution.

One has great personal objection to even the appearance of cheap advertisement through the medium of your correspondence columns, but I feel that I am called upon to reply to Mr. C. Johnson's communication relative to electrical distribution in your number for September 28th, in which he criticises my paper, read before the British Association, and my remarks on the Colchester system.

I feel that at all times "comparisons are odious," and I should not have made any reference to the Colchester or Mr. Brush's system had I been aware that they had not been abandoned in the full acceptance of the term. That the Colchester system may be revived is another matter, but, from overtures made to me personally by various parties during the past year or two relative to the acquirement of the plant at Colchester, and the fact that the company formed there had ceased to supply, I considered I was justified in the position I took.

I think your correspondent fails to see, or possibly I have failed to make clear, one of the great features that I claim for my system, viz., that of being able at all times during the 24 hours to supply a local battery with increments of charge from the charging station without at any moment putting the charging main in actual contact with the local discharge battery, and without interrupting the continuity of the local circuit, which will always be available for supply during the 24 hours, by day or by night, but whose maximum capacity of discharge will be limited to eight hours. Naturally, I would not propose to add one-fourth to the already large outlay required for batteries unless there were *quid pro quo*. Take, for example, a 48-volt circuit on the local. It would be very easy to make a device similar to mine to charge that battery at the same time as it is discharged, as Mr. Brush did, but which shall charge portions of the battery, say, fourths or thirds consecutively. But this would be attended with a serious danger if a number of such arrangements were in one circuit, owing to their liability to leakage through the battery or the charging main to earth, or through the electric light fittings and connections employed therewith. It is unwise to give too great a prominence to the dangers connected with the charging or operating of any system through the use of high tension currents in the main, but I fail to see how these two things could be combined except either by duplication, in which case you considerably increase the cost of your batteries, leaving one set in the main and the other discharging, or else by some such method as mine, where I use a set that is a divisor of the local—a fourth or a third or other division according to the batteries I wish to charge or discharge.

Further, your correspondent does not appear to realise another feature, which is that in this method we can be using our charging plant for 24 hours in the day, which is always important when first cost of plant and of operating the same is taken into consideration. Besides this we can use a maximum current equal to the charging capacity of the cells with only one-third of the E.M.F. of these said cells in the local, if considered as being connected in series. This, I maintain, is no mean advantage, and I cannot do better than quote, as I did in my paper, the example of the 100 houses or centres worked on the direct series charging system and on my divisional charging system respectively.

Then some notice must be taken of the wear and tear and depreciation of the batteries themselves. Now, although we do employ 25 per cent. more cells, yet I have positively proved that cells charged by my method are kept in a much better condition, and that the saving on depreciation will more than cover the additional outlay of first expense. Further, batteries charged for a period of, say, two minutes, do not, if of proper dimensions, according to the charging current, require the same E.M.F. to ensure their charging, that cells do that are continuously charged for a long period of time, nor do they in discharging lower their E.M.F. to the same point as those continuously discharged for a long period of time. Your correspondent evidently overlooks the fact that all the cells are constantly receiving increments of charge or refreshment at least every eight minutes. "The proof of the pudding lies in the eating," and, after seven or eight months' work under careful observation, it has been found that the E.M.F. has never fallen below 48 volts, and has only slowly, without perceptible change in the lights, gradually risen to 50 or 51 volts in the local, at which E.M.F. the batteries cut themselves automatically out of the charging circuit. Your correspondent must remember that there is a difference between taking the E.M.F. of a set of cells, as a whole, fully charged, and a set of cells with a portion of them refreshed, and not fully charged. For fear of trespassing on your space, I should be happy to give him or others of yours readers personally full details of my observations in this field.

H. Edmunds.

October 17th, 1888.

Voltage of Lamps.

The discussion which has recently taken place in electrical circles and in the REVIEW on the above subject, although very interesting and useful, is scarcely, I think, of so much importance to users of these lamps as some means of overcoming the gradual deterioration in the light-giving power of the lamps. I have used them more or less from their first introduction, and find, after they have been in use a few months a considerably larger pressure is required to get the original lamp-power from them.

T. B. D.

October 16th, 1888.

Electric Light v. Gas at Barnet.

Since we have obtained the contract and have carried out the lighting at Barnet (the first town in the United Kingdom whose streets are entirely lighted by the electric light) we have been subjected to all manner of abuse from interested opponents, in the local papers, and elsewhere, chiefly in the shape of anonymous letters (the most contemptible form of criticism), the merest perusal of which is sufficient to show their origin.

The report of a visit to see the electric light at Barnet was published in a Blyth paper, as coming from a Blyth man. This report, it is believed, was written by an unfriendly gas shareholder, a resident in Barnet. Of course it was copied in the *Barnet Press*, and extracts, we regret to say, in some of the electrical papers. The malicious and yet ludicrous nature of that report will be apparent when it is known that the writer states that electric light lamps (of 50 candle-power) gave much less light than an ordinary gas lamp (of about 14 candle-power). The absurdity of this statement is evident by a glance at the two lamps; the writer of the report makes other misleading and erroneous statements.

The editor of the *Luton Times* was, we are so informed, invited to Barnet to write down the electric light, and after spending "a very happy evening" (*vide* report) proceeds to do so in a very amusing, but, of course, totally erroneous and misleading manner; it is sufficient to say that he stretches his imagination to the height of absurdity when he writes that he had to obtain the assistance of a policeman, and to borrow the policeman's lantern to enable him to find an electric lamp (of 50 C.P.). We suggest that the policeman had to see him home, and that he occasionally saw stars. Many other equally stupid and misleading letters and criticisms have appeared, and perhaps a few facts as a corrective may not be out of place.

Now as to the light. This is the first installation of town lighting by incandescence lamps in series, and we had enormous difficulties in obtaining the novel fittings in the short time at our disposal. Our contract was not signed until July 6th. We did not obtain the official plan showing the position and number of the lamps until some time after, and we found that we had to fit up 71 street lamps, posts, five miles overhead wires, nearly one mile of underground wire, dynamo, engines, &c., in about five weeks. We asked the Local Board for six months in which to do the work permanently. This they were unable to grant, as the gas company's contract expired at the end of August, and we had to light up on the 1st September. Under such circumstances we were compelled to use temporary appliances, which we are now replacing by permanent plant, and we expect shortly to have our duplicate sets of engines, dynamos, &c., in proper working order.

Our contract is for 71 32-C.P. lamps, but we have substituted many 50 C.P. lamps in the High Street, &c., in order to make a good display, and the opinion of competent and unbiased persons is that the light is a success, and we are much gratified at the orders we have received for private lighting, and the general good feeling shown towards us by the townspeople of Barnet. The Barnet lighting is no doubt the stepping stone to an immense business in town lighting; we have already had numerous applications from other towns, and we consider the unfair criticism we have received is due to the envy of our opponents, and we take it as a tribute and measure of the success we have already achieved.

When we are fixed up permanently, of which we will give you due notice, we shall be glad to see you and explain the whole system, and invite your personal criticism.

Henry F. Joel & Co.

October 17th, 1888.

The Phonograph and Graphophone.

Mr. Campbell Swinton does not appear to have read your article on the phonograph as carefully as he should have done before criticising it. It appears to him "you fall to some extent into the error of assuming the ultimate capabilities of the instrument to be limited to its existing capabilities in its present form," whereas you wrote: "The instrument will yet undergo many modifications." . . . "It is an invention of importance which, in the distant future, may find some general use."

Then Mr. Swinton takes up the familiar story of successful inventions which were in their early days considered of no importance. Such reasoning is difficult to be kept under, but followed to its logical conclusion, it would come to about this: because somebody at some other time failed to see that some other invention was of incalculable value, therefore every other body at every other time, who fails to see incalculable value in every other invention, must be as wrong as the first mentioned "somebody." Why should not your criticism on the water battery be replied to in this fashion, and you be silenced once for all.

But is Mr. Swinton correct in his recollection of the time during which the telephone was looked upon as a toy? Is it not, on the contrary, a fact that the telephone was a remarkable exception to the time generally necessary to the development of new inventions? The telephone was, perhaps, regarded as a toy so long as communication between two points was concerned, in which its use was not urgently required; but when once the exchange system was suggested, it did not long remain dormant. Introduced, as it was, in 1876, an exchange was started in 1877, twenty exchanges were started in 1878, and ninety-one more in 1879. If Mr. Swinton intended his remarks to apply to Great Britain, he has not many years to make up his "several" between 1876 and 1879, when exchanges were being started in London and the provinces.

The flat surface was amongst the many modifications suggested by Edison at the time his original phonograph was brought out; and, if my recollection serves me aright, wax was the substance proposed, the record being traced in spiral form. The continued use of the cylindrical form of phonogram implies its superiority in the view of the inventor.

Mr. Swinton doubtless knows something of the paralysing effect of monopolies, and as he apparently contemplates that there will shortly be in use as many forms of phonograph as there are now sewing machines, the discussion of this subject in your columns may do some good in leading the manufacturers of the present and the future to adopt uniformity of size and style to the recording and reproducing apparatus, confining their differences to build and motive power.

In considering the suitability of the phonograph for general use it should not be lost sight of that it offers few, if any, advantages to the recipient, but only to the sender of a communication.

Comparisons with the telephone, too, are not apposite. The telephone does something more than reproduce speech: it transmits it. It affords the opportunity of conversation, and thus avoids one of the difficulties you have alluded to. It is no more difficult to talk through the telephone than it is to converse. The difference between a telephonic communication and a phonographic communication is the difference between a friendly conversation and a set speech.

K.